TOPICS OF THE MONTH

Fertiliser industry trends

IN his annual review as chairman of Fisons Ltd., Mr. F. G. C. Fison raised some thought-provoking, as well as some heartening, points for the fertiliser industry to consider. For instance, while Fisons' sales for the year—including for the first time those of Fisons Pest Control Ltd.—were £32 million compared with £28 million in the previous year, the group trading profit (including dividends from the associated companies and after deducting interest charges) was £2,656,276 compared with £2,956,476. An important reason for this reduced profit has been the lower margins on fertilisers. The sales targets were achieved, but a continuous rise in cost in virtually all items entering into fertiliser manufacture prevented Fisons from maintaining their profits.

The continuous rise in cost affected all the materials used. To a minor extent this was the result of price increases made by the producers of raw materials, but the larger part of the increase resulted from the very rapid rise in freight rates. ' I do not think that it is generally appreciated,' said Mr. Fison, ' how large a part freight rates in fact play in our economy.'

Another circumstance affecting fertiliser manufacture which is perhaps not as well appreciated as it should be is the importance of the French Moroccan sources of supply. During the recent riots there, substantial damage was sustained at one of the mines. Referring to this damage in his review, Mr. Fison paid tribute to the energy displayed by the management of the phosphate mines in dealing with this difficult situation, and reported that supplies of rock had at no time been held up. He also pointed out that the dependence of Europe on the Moroccan mines for phosphate rock is such that, if there were any breakdown of supplies for more than a few weeks, there would be a major crisis in the industry over a large part of the world.

However, the present healthiness of the industry is evident from Mr. Fison's revelation that his company's fertiliser factories have all been working at full pressure throughout the year. In particular, the triple superphosphate factory at Immingham has achieved an output much higher than its rated capacity.

New titanium fabrication factory

A FACTORY for the fabrication of titanium is to be built by Imperial Chemical Industries Ltd. near its existing works at Waunarlwydd (Swansea). Work will begin as soon as possible and it is hoped that the new factory, which will cost about £2 million and employ some 250 people, will be in production in 1958.

Considerable pioneer research and development work by I.C.I. has culminated this year in the commissioning of two large-scale plants for the production of titanium and its alloys. The first of these, built by the company's General Chemicals Division at Wilton in Yorkshire, is concerned with the extraction of metallic titanium and can produce 1,500 tons p.a. of raw titanium. The second, at the Kynock works of the Metals Division in Birmingham, is responsible for melting granular titanium produced at Wilton, and forging it into slabs and bars for further fabrication.

Some fabrication into wrought forms—sheet, strip, plate, rod, tube and wire—is at present being carried out at Kynoch works and in other Metals Division factories, including Landore and Waunarlwydd works in south Wales. The demand for fabricated products (particularly sheet, rod and tube for the aircraft industry) is, however, developing so rapidly that the company has decided to build a new factory where fabrication processes can be more extensively developed.

At Waunarlwydd the company has land which not only meets immediate requirements but allows, if necessary, for expansion. The new industry is similar in some ways to that already established at Waunarlwydd—the fabrication of aluminium and its alloys.

Titanium prices in the U.S.

THE news of I.C.I.'s new titanium plant comes at a time when there is much speculation about the price of titanium and its possible reduction in the near future, not only in the U.K., but also in the United States, which is the biggest producer. One leading supplier there has forecast that the price will be reduced drastically within a couple of years, and that it would very possibly be down 50%. Others thought such a drop might take a little longer.

Commenting on titanium prices recently, a correspondent of the *New York Times*, Jack R. Ryan, points out that a real price breakthrough would not only be cheering news to the defence planners and aircraft makers, but would also be welcomed heartily by other potential users in the petroleum, chemical and transportation fields. Base prices of titanium mill products in the United States are given roughly as $14/lb. for sheet and strip, compared with 44½ cents/lb. for stainless steel, $11½/lb. for plates (stainless steel, 40½ cents) and $8½/lb. for bar and forging billets (stainless steel, 31¾ cents).

Some weeks ago, the U.S. Government stopped buying primary titanium for its ' revolving stockpile ' —a programme designed to provide a market for excess metal and at the same time to build a reserve supply. Purchasing was halted to allow fabricating techniques and consumption to catch up with the primary supply. At first, this looked like another setback for titanium. But, as things turned out, the Government's timing was excellent. For, beginning in October, there was a sharp increase in demand.

The Titanium Metals Corporation of America, the only fully integrated producer, suddenly found it was booking orders for mill products almost to capacity. Rem-Cru Titanium, a leading supplier of mill products, reported that fourth-quarter orders were running bigger than ever before and said its melt shop, where sponge is vacuum-melted into ingots for milling, was working right around the clock. And some industry and Government sources said there was a strong possibility that supplies of titanium mill products might be so tight by next March that severe allocation programmes would have to be established.

Prices of primary titanium sponge in the United States have been trimmed four times in two years. These cuts reflected important refinements in the complex process of reducing the metal from ore.

Prospects for explosives

BRITAIN'S industrial explosives industry employs about 12,000 people at present and the annual turnover is approximately £17 million. The steady expansion in output, which satisfies a greatly increased home demand and a very substantial growth in export trade, is shown by the production of 60,000 short tons in 1954 compared with 52,000 in 1951, 46,000 in 1948 and 25,000 in 1937.

These figures were recently given by a *Financial Times* correspondent, according to whom there are seven companies engaged in this industry: Imperial Chemical Industries Ltd. (Nobel Division), Cooke's Explosives Ltd., Colliery Explosives Ltd., Explosives & Chemical Products Ltd., the Yorkshire Detonator Co. Ltd., Vickers-Armstrongs (Engineers) Ltd. (Thames Ammunition) and Burrowite Explosives Ltd. In Britain's coal mines, 28,000 tons of explosives are consumed annually, but many thousands of tons are also needed every year by the metal-mining, opencast coal-mining and quarrying industries, and in civil engineering demolition, excavation and tunnelling. The extensive hydroelectric projects, constructed and under construction, undertaken in Britain since the war have made a significant demand on the industry.

However, although home demands absorb a large proportion of manufacture, the United Kingdom has a substantial export trade for, as world manufacturing production of all sorts of goods has expanded, there has been a necessary expansion in demand for raw materials, many of which are won with the aid of explosives. Exports of explosives have more than doubled in quantity between the years 1937 and 1954.

It is also pointed out that the future pattern of explosives consumption in Britain depends on the future of coal. For many years explosives consumption in coal mining has been rising faster than coal production. In many respects explosives are an alternative form of energy, and this increase of usage comes from a natural tendency to ease the labour of mining. Technical developments in coal mining may halt this increase, but elsewhere in the country there is a slow but steady long-term increase in explosives consumption.

Iron-from-nickel ores plant begins trial operation

BUILT at a cost of $19 million, the first unit of the iron ore recovery plant of the International Nickel Co. of Canada Ltd., at Copper Cliff, Ontario, has been virtually completed, less than two years after construction was initiated.

Announcing this achievement in a letter to shareholders, Dr. J. F. Thompson, chairman of the company, stated that trial operation of the equipment had begun and that the plant was scheduled to go into production in the near future. The plant employs a process for the recovery of nickel and of iron ore from nickeliferous pyrrhotite.

This development by Inco, which was briefly referred to in our January 1954 issue, undoubtedly constitutes an outstanding advance in extractive metallurgy. Other nickel recovery processes in current commercial operation do not usefully recover the iron content of the ore. Years of laboratory and pilot-plant study led to the solution of this problem with a new process which recovers the iron content of the pyrrhotite in the form of a high-grade iron ore, the nickel content being removed by an atmospheric-pressure ammonia leaching process.

The first unit will treat 1,000 tons of pyrrhotite concentrate daily. After operation of the unit at full capacity, expansion is planned to permit an ultimate annual output of about 1 million tons of iron ore higher in grade than any now produced in quantity in North America. This ore will contain more than 65% iron and less than 2% silica. It is expected that the ore will command a premium price for direct use in open-hearth and electric furnace production by the North American steel industry, which has been largely dependent on imports from foreign countries for its requirements of ore of such high quality.

The new process is one of a series of planned long-range developments by which International Nickel's ore treatment processes are being revolutionised. Another of Inco's projects in the Sudbury District of Ontario is concerned with the open-pit mining of nickel, and involves an engineering procedure that is unusual in open-pit mining. The company is driving two vehicular tunnels, with a total length of 2,200 ft., in the walls of its Frood-Stobie open pit to permit greater recovery of ore by low-cost surface methods. The tunnels will take the place of sections of the main ramp road which winds for almost two miles around the sides of the open pit, now nearly 600 ft. deep. When the tunnels are completed, pit traffic will be routed through them, and the affected portions of the ramp road will disappear as the ore over which they lie is mined. The usual surface-mining procedure of churn drilling, blasting and trucking will be used to recover the ore beneath the ramp.

International Nickel's report for the nine months ended September 30, 1955, shows that the net earnings, in terms of U.S. currency, were $20,221,000 higher than in the corresponding 1954 period—or $4.53 on common compared with $3.15.

Aggregates from fly ash

THERE is an increasing shortage of clinker for use as aggregate as more and more power stations turn over to using pulverised fuel. At the same time the change over is resulting in an increasing production of pulverised fuel ash, a finely divided fly ash which can be disposed of only at a cost of up to 10s./ton.

The Building Research Station, which has already shown how bricks can be made from fly ash, has now developed a process by which this former waste material can be pelletised and kilned to make good-quality aggregates. One firm is to produce 65,000 tons/year of aggregates at Battersea in this way and other firms are interested in the process.

The present demand for clinker has been estimated at more than 5 million cu. yd. p.a., but the supply has been dropping, so some firms have already given up the manufacture of clinker products. The output of fly ash from power stations is now $2\frac{3}{4}$ million tons p.a., enough to produce 4 million cu. yd. of aggregate. This output is likely to increase to 4 million tons p.a. of fly ash, sufficient to meet the expected demand for aggregate.

The process involves the pelletising of the raw ash with water in a rotary pelletiser, followed by sintering in a vertical kiln. No fuel costs are incurred in operating the kiln as the fly ash itself contains about 5% unburnt fuel, sufficient to make the pellets self-firing. At present the aggregate costs more than clinker.

Blocks made from the new aggregates have better appearance than clinker blocks, they weigh 75 lb./cu.ft. and can withstand pressures of 1,000 p.s.i. They have a lower drying shrinkage and there are no concentrations of unburnt coal, lime or pyrites in them to cause troubles in completed structures.

Comical Engineering Terms

"UNSTEADY STATE"

British Standards progress

AS might be expected, the largest section of the British Standards Institution's annual report* is concerned with the projects for British Standards which have been under consideration during the year by some 60 major industries.

Among important standards issued during the year are B.S. 2455, dealing with the sampling and testing of boiler water deposits, and B.S. 2486, covering the treatment for land boilers. A complete series of British Standards now exists, thus enabling boiler plant managers to ensure that there is complete and accurate control of the water used for generation of steam in boilers of all descriptions. Another project is concerned with pressure vessels, for B.S. 1500, the provisional standard for fusion-welded pressure vessels which was issued some time ago, is being reviewed and the intention is to concentrate on the requirements relating to carbon and low-alloy steel pressure vessels and to issue these as the first part of a series which will cover all types of pressure vessels. With a view to collecting information on which requirements for non-ferrous pressure vessels can be based, a panel has been formed to consider permissible design stresses and temperatures for copper and copper alloys, aluminium and aluminium alloys, and nickel and nickel alloys.

These matters are discussed—along with standards for medical gas cylinders, for corrosion protection by metal spraying, and for silver plating—in that part of the report which covers the chemical engineering side of the Engineering Division's activities. There are, of course, many other standards and projects, mentioned elsewhere, which are of interest to the chemical engineer, as well as to the chemical and numerous related industries. For instance, the preparation of a series of valve standards for the petroleum industry has been continued and two of these standards have been published, while, for glass pipeline and fittings, a standard has been published (B.S. 2598) which should prove of considerable value to the chemical, food and allied industries.

In the heavy chemicals field, the drafting of a standard for barytes is to proceed on the basis of such data as are at present available, pressure of work having prevented the National Physical Laboratory from carrying out the *x*-ray tests originally planned. Two standards, B.S. 2540 and B.S. 2541, dealing respectively with silica gel and activated alumina used as desiccants for packages, have been published. Though the grade of desiccant described in these standards may find application for uses other than packaging, the limits for dust, *p*H reaction and ammonia and ammonium compounds have been specified with the object of affording protection to the

*'Annual Report 1954-5,' British Standards Institution, 5s.

contents of packages against risk of corrosion caused by fine particles of the desiccant leaking from their containing envelope into the bulk of the package. The work on desiccant for use in dynamic drying is still in progress.

These are but a few of the subjects covered and other standards published or contemplated are concerned with (to select a few at random) flow measurement, glycerine, flameproof lighting fittings, viscosity, and the sampling and testing of ores.

Acid-resisting floors

A SUBSTANTIAL and well-designed acid-resisting floor is essential where any kind of acid tank or container is erected, but the knowledge of how to prepare and construct such a floor is not widespread. In a paper given to the Sheffield and District Branch of the Incorporated Plant Engineers, which dealt with factory floors generally, Mr. A. E. Rice, of Prodorite Ltd., included some very practical comments on acid-resisting flooring which should be very helpful to engineers interested in this subject.

For instance, he pointed out that, when designing a floor, it is necessary to ascertain the full chemical and traffic conditions in order to choose materials which will be completely suitable. Again, it is necessary to check the sub-soil for acid contamination which, if it exists, must be suitably dealt with. For ground floors, preparation of the sub-surface is followed by treatment with bituminous paint. The purpose of this treatment is principally to separate the concrete from the acid-resisting cement used in bedding the specified acid-resisting paviors. Suspended floors are generally subject to movement and a tendency to crack immediately above beams. Unless suitable precautions are taken, any cracks developing in the concrete are transmitted to the acid-resisting paving, where their presence is indicated by opening up of the joints between paviors.

Acid-resisting paviors or bricks of suitable size are employed, set in the appropriate cement. The standard English sizes are 9 in. × 4½ in. × 2 in. or 10 in. × 5 in. × 2 in. The porosity of a good acid-resisting pavior is as low as 0.2 and is certainly not higher than 3% by weight. Such paviors and bricks are made from suitable brick earth that is usually quarried at a site adjacent to the brickworks. The earth is crushed, ground and mixed with water to form a plastic-like material, which is pressed into blocks or otherwise cut to the desired shape. The blocks are burned at a high temperature to vitrify them.

But acid-resisting flooring is not simply a matter of laying paviors. For instance, it is necessary to provide an efficient drainage system capable of disposing of any acid spillage, and it is essential to provide well-designed channels for this purpose. Again, acid-proof paving is sufficient only up to the points where it encounters obstacles such as surrounding walls, piers, stanchion bases and other vertical surfaces. Methods are available for forming a skirting in such locations.

The choice of the most suitable acid-resisting cement for setting the paviors or bricks depends on the chemical conditions. The principal cements used in chemical engineering are the silicate type—sodium silicate and potassium silicate—latex cements, synthetic resin cements and the pouring types (sulphur and bitumen).

Higher octane petroleum fuels by new process

A NEW petroleum refining process, *Rexforming*, has been developed by the Universal Oil Products Co., of Illinois, U.S., and it is claimed that this will enable refiners to produce superior petroleum fuels, including products of over 100-clear-octane rating. In this process, there are several integrated parts: the feed prefractionator, the reaction section, a stabiliser and an extraction section. In the processing of a full boiling-range petrol, the charging stock is fed to a reboiled prefractionator which removes a light gasoline fraction. The side-cut from this column is the combined feed to the reaction section. The flow through the reactors which contain the platforming catalyst, and through the heaters, is similar to that of a platforming unit. The reactor effluent, after cooling, passes to a separator, from which a hydrogen-rich gas is circulated to the reactors. The net vent hydrogen is also removed from this separator.

The separator liquid is then fed to a stabiliser, which in this case serves as a debutaniser. The stabilised material is charged to an extraction column which continuously rejects, from the top of the column, the low-octane-number components. This rejected stream is returned to mix with fresh feed, and a selective conversion of low-octane heavy paraffins to high-octane components is achieved. Separation in the extractor is selective because the higher-boiling non-aromatics are least soluble in the solvent. Conversely, the aromatics and the lower-boiling non-aromatics are relatively more soluble and are removed from the extractor with the rich solvent.

Dissolved hydrocarbons are removed from the rich solvent by stripping, thus yielding petrol of well-balanced boiling range. Lean solvent from the stripper is returned to the extractor to complete the solvent cycle.

In the *Rexforming* process, the reaction section can be operated at mild conditions to produce an effluent having an octane number of 75 to 85 F-1 clear and containing from 35 to 45% aromatics. The extraction section separates from this effluent a stream of increased aromatic content which contains the highest-octane paraffins in the reactor effluent. This stream, the *Rexformate*, when of 100 clear octane number, will contain from 60 to 56% aromatics. The remaining low-octane higher-boiling paraffins are left in the raffinate stream to be recycled to the reforming section for further processing. Small amounts of aromatics can be left in the recycle raffinate stream without affecting the efficiency of the process.

The process was discussed in more detail by V. Evans in our associate journal, *Petroleum*, in November.

HIGH VACUUM TECHNIQUE

Pumping systems and pumping speeds; gauges and leak detection; general vacuum techniques; vacuum distillation, evaporation and drying

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RECENT publications on high-vacuum technique and applications have centred around pump design and techniques for producing and maintaining ultra-high vacua, low-pressure gauges, molecular distillation apparatus, and the processes of freeze drying and metallisation by vacuum evaporation.

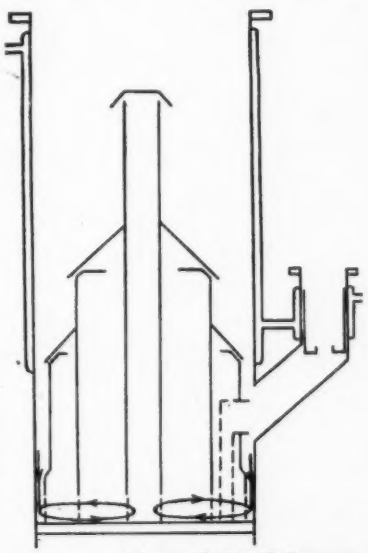
Two books on freeze drying have appeared. The first, edited by Harris,[1] contains 14 chapters by different authors, experts in their fields, and has as the main theme freeze drying and vacuum sublimation processes for the preservation of blood products, foodstuffs, virus preparations, bacteria and tissue material. The second, by Neumann,[2] presents the German viewpoints and developments in similar spheres of applications.

According to an advance announcement,[3] a high-vacuum symposium was held in Pittsburgh, U.S.A., in June 1955, at which papers were presented on nomenclature and standards, new equipment and instruments, fundamental developments in technology, methods and techniques, and applications and processes. This symposium, which was under the auspices of the Committee on Vacuum Technique Inc., recalls the convention held in Scotland in 1948; if a similar practice is followed of issuing the collected papers under a single volume, this should provide an excellent survey of present-day practices.

Diffusion pumps

The factors influencing the speed of vacuum pumps, and indeed the very measurements of speeds, are still somewhat controversial. Because of their difficulty of resolution, designs remain semi-empirical. The same holds for the ultimate degrees of vacua attainable, and the influence of system design on these and on speeds. Reichard[4] has investigated the influence on speed and throughput for glass mercury diffusion pumps of various design features including heat input, jet size, bore of mercury tube and temperature of the cooling water and has applied the results to the development of single- and three-stage 20-mm. pumps. Monch[5] has described a glass mercury diffusion pump with a removable jet, which he claims to have a speed at 0.1 mm. Hg considerably greater than that of conventional commercial mercury pumps.

Riddiford and Coe[6] considered the factors affecting the speed of high-speed oil diffusion pumps, and developed three- or four-stage 16-cm. pumps for use on the Birmingham synchrotron. In a later paper[7] they discuss the final vacua obtainable with oil diffusion pumps of the type shown in Fig. 1, with which no refrigerant is used (in order not to reduce pumping speeds). The oils normally used are really mixtures, and at least one good stage of fractionation is necessary if residual pressures as low as 3×10^{-7} mm. Hg are to be obtained. Under fractionating conditions, purification of the oil by pre-removal of less-volatile components does not improve the ultimate vacuum. Evidence from vapour-pressure measurements suggests that at the baffle temperatures the oils in common use—*Apiezon* C, *Octoil* S and silicone DC 703—all have vapour pressures less than 10^{-8} mm. Hg, and thus that the residual pressure is due to oil decomposition in the boiler. The evidence is that the products cover an appreciable spectrum of molecular weights. Of the three oils, *Apiezon* C gave the lowest residual pressure, but the silicone was most resistant to the presence of air while hot—in agreement with previous work. These authors suggest that no major improvement in ultimate vacuum is likely without the use of refrigerants.



[Courtesy: J. Scientific Instruments

Fig. 1. Diagram of 16-cm. oil diffusion pump developed for the Birmingham synchrotron.

Hayashi,[8] in an attempt to find out whether metals catalyse the decomposition of pump oils and whether the gaseous products limit the ultimate vacua, measured the quantities of non-condensing gases accumulating from the decomposition products in a vessel in a given time for two typical oils—an ester and silicone DC 703. For both, the rate of accumulation was about 10^{-6} litre-micron Hg per sq. cm. of oil surface per second, which was considered to be low enough not to contribute more than about 10^{-8} mm. Hg to the ultimate vacua. The ester showed evidence of slight catalytic decomposition, whereas the silicone did not.

Ion pumps for ultra-high vacua

There is no doubt of the interest aroused by the Alpert ion-pump using an ionisation gauge for the final pumping, which was discussed in our last review.[9] The limiting ultimate vacuum of 5 to 10×10^{-11} mm. Hg was considered to be due to the diffusion of helium through the glass from the air. This has been confirmed by Varnerin and White,[10] who obtained pressures less than 10^{-11} mm. Hg when

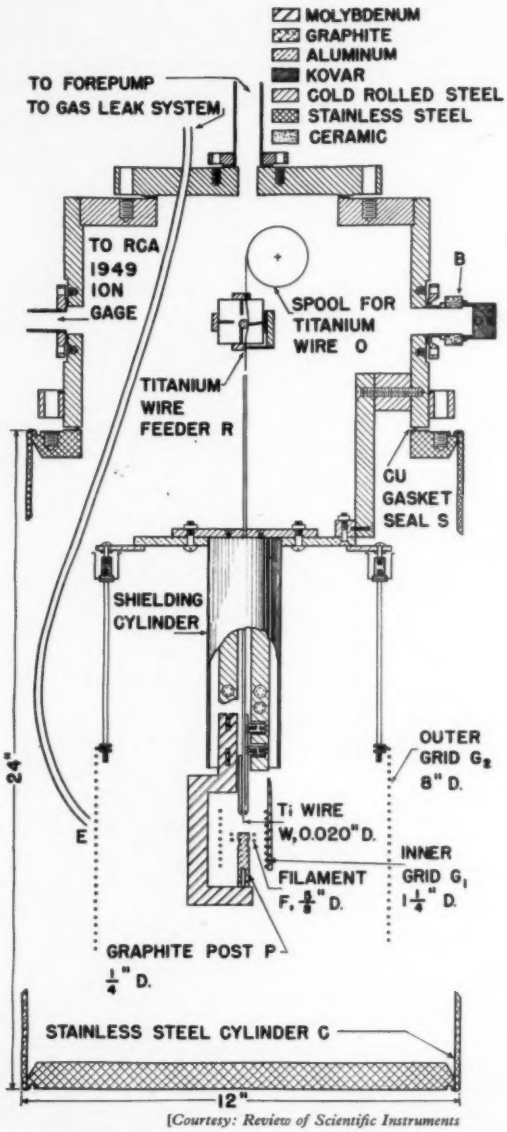
the Alpert ionisation gauge was enclosed in a continuously evacuated vessel and used to pump itself. Alpert and co-workers[11] have also measured directly the diffusion of helium through glass of the type used for the gauges, and their results support the previous contentions.

This 'clean-up' of gases under ionising conditions is, of course, not of itself new. It has been common practice in the electronics tube industries for some time to 'age' or clean-up individual tubes under such operating conditions, and in gas discharge tubes the slow disappearance of the gas filling with time of running may constitute a nuisance. The novelty is in the use of such a tube for pumping other tubes or vessels, and present interest aims at improving on the pumping speed and capacity at low pressures.

Gurewitsch and Westendorp[12] have described a small, simply constructed ion pump operating on the principle of the Penning cold ionisation gauge, which can be used over the pressure range 0.1 to 10^{-7} mm. Hg, can sorb 70 cc. (N.T.P.) air without evidence of saturation and can reduce the pressure of hydrogen in a 3-l. vessel from 50 to 0.2 micron in 9 min. A 1-in.-diam. Mo ring is mounted between two 1-in.-diam. parallel C or Ti plates in a round stainless-steel box (with suitable insulation). A permanent magnet and pole pieces establish a magnetic field of 1,000 gauss perpendicular to the plates, and a potential of 1 to 10 kv. is applied between the Mo anode and the plate cathodes. The cold-emitted electrons are forced by the magnetic field to oscillate many times between the plates before being collected by the anode, and in their lengthened path may each ionise numerous gas molecules which are then driven into the negative plates where they release further electrons.

It is also well known that metal sputtered or evaporated in a discharge will clean up gas, and that certain metals evaporated in the absence of any ionising conditions are very good 'getters' for residual gases. Wagener[13] has recently published a lengthy survey on such getters which of themselves are suitable normally for final evacuation of tubes or vessels of only relatively small size. Tsukakoshi[14] combined such a getter source (using evaporated barium metal) with a Philips hot-cathode discharge tube in a 15-cm.-diam. glass bulb to serve as a good high-vacuum pump with speeds of 80 l./sec.$^{-1}$ for oxygen at 3×10^{-7} mm. Hg pressure, 8 l./sec.$^{-1}$ for hydrogen at 2.5×10^{-6} mm. Hg, and intermediate speeds for carbon dioxide and water vapour.

Davis and Divatia[15] have described *Evapor-ion* pumps, of which their design No. 2 (see Fig. 2) is stated to have speeds for H_2, N_2 and O_2, air, Ar and He, respectively, of 7,000 to 8,000, 6,500 to 7,500, 1,000, 9 and 4 l./sec.$^{-1}$ at pressures around 10^{-7} mm. Hg. This combines the ionisation of residual gas molecules by electron impact with the gettering action of titanium, which is continuously evaporated from wire by a feeder mechanism on to the pump wall which is maintained at about 20°C. As indicated in Fig. 2, Ti wire *W* is fed by the feeder *R* on to the graphite post *P*, which is heated by bombardment of electrons emitted from the spiral filament *F*, maintained at a negative potential to *P*; the outer cylinder *C* is of stainless steel. The motion to the feeder is provided through a vacuum-tight seal using copper or aluminium gaskets, and variable rates of feed from 0.35 to 17 mg. Ti/min.$^{-1}$ can be obtained. Prior to operation, the vacuum system is rough-pumped, the stainless-steel chamber baked on the fore pumps at 300°C. for 6 hr. to remove gas which would otherwise cause a glow dis-

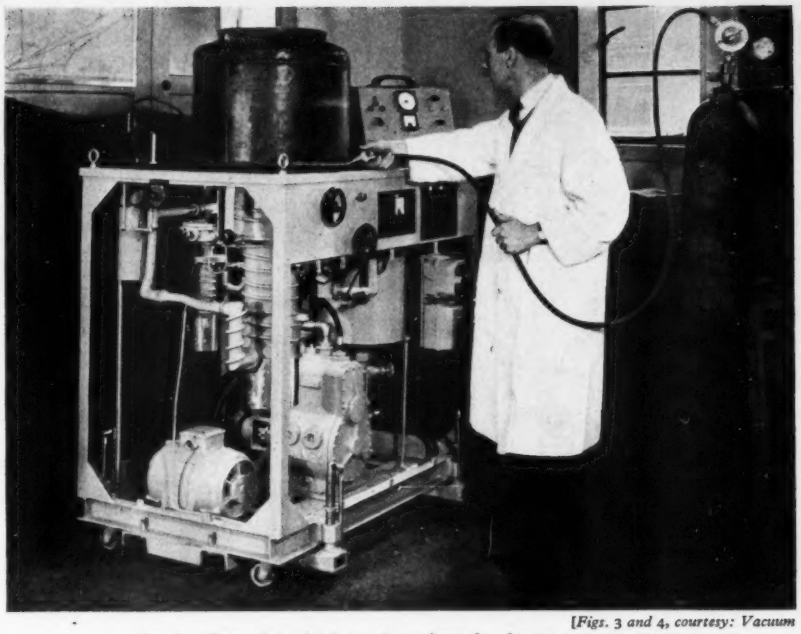


[Courtesy: Review of Scientific Instruments

Fig. 2. 'Evapor-ion' pump of Davis and Divatia.[15]

charge, the filament is heated with the potential applied between F and P so that the graphite post attains a temperature of 2,000°C., and the fore pump is cut off. The emitted electrons cause ion-pumping as in the ionisation gauge of Alpert, and the above speeds are obtained at optimal feed rates of 7 mg. Ti/min.$^{-1}$ and wall temperatures of 20°C. The pumping speed decreases with increasing wall temperature and as the pressure increases from 10^{-7} to 10^{-4} mm. Hg. Because of the low rate for helium, the pump may be used as its own leak detector with a probe of helium gas.

While these pumps have been designed for somewhat specialised applications—that of Davis and Divatia was for use on the accelerator tube of a high-voltage electrostatic accelerator—and in general require ancillary electrical equipment for providing the requisite fields, they do offer interesting departures from the conventional diffusion type of pump with inherent limitations for ultra-high-vacuum applications.



[*Figs. 3 and 4, courtesy: Vacuum*

Fig. 3. Complete leak-testing plant for large components.

Measurement of pumping speeds

One of the difficulties in measuring the speeds of pumps is that the absolute accuracy of the vacuum-gauge calibration may affect the results. Oatley[16] has described a procedure which is independent of this accuracy and which may also be applied to measuring the resistance to flow at low pressures of any tube or channel of which a small-scale model can be made. Basically the method consists of placing above the mouth of the pump a rotatable disc carrying holes of varying conductances S_2 (calculable from hole dimensions), and connecting the head to any suitable pressure gauge. At pressure where molecular flow obtains, if S_1 is the speed of the pump and p is the pressure, it can be shown that

$$k.p = \frac{1}{S_1} + \frac{1}{S_2}$$

where k is a constant. If the pressure is measured with a constant air leak at various S_2 values, that is, with different holes in the disc above the pump opening, and the measured p is plotted against $1/S_2$, then as long as the gauge pressure to main pressure remains constant, the intercept of the resultant straight line will be $1/S_1$. Further, if the special shape under investigation, for instance a T-piece, is put in one of the holes in the disc and the p value determined with this in place, its corresponding S value can be obtained by interpolation on the straight line. Oatley obtained

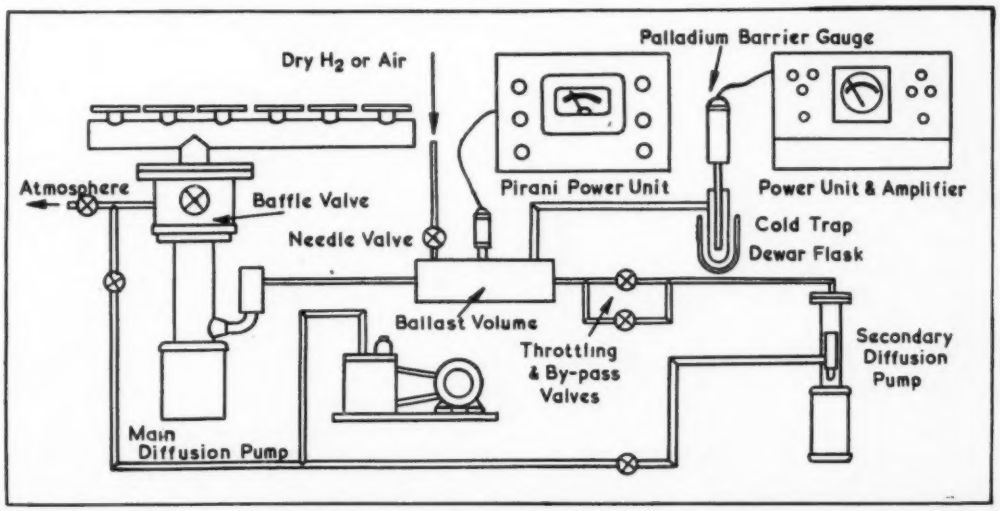


Fig. 4. Diagram of complete leak-testing plant.

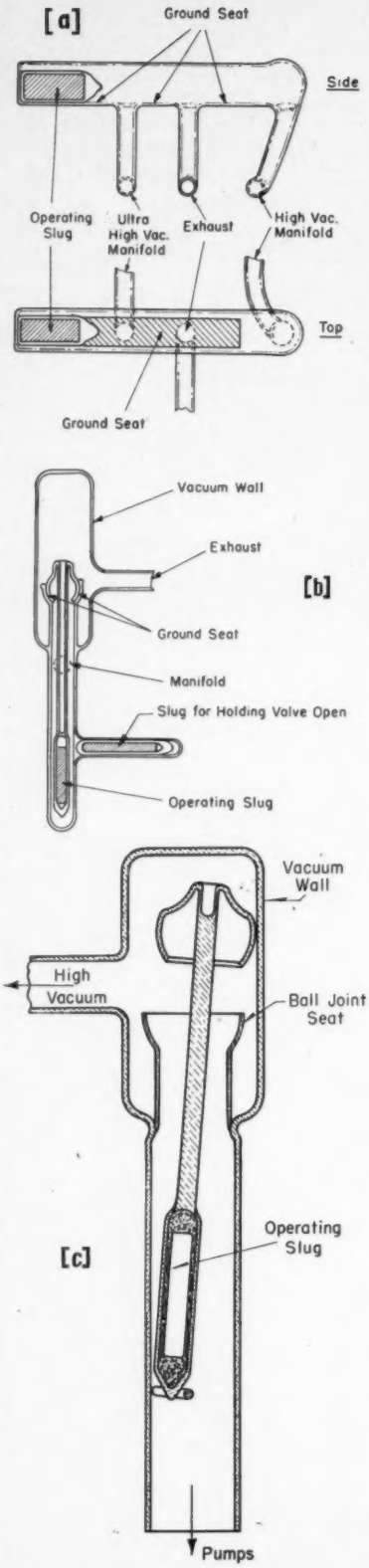
results for cylindrical tubes, rectangle bends, T-pieces spaces between concentric tubes, and for baffled vapour traps. In general, experimental results were less than values calculated from previously available data, and baffled vapour traps gave particularly low conductances.

In complicated vacuum systems of large size it is often difficult to evaluate the effect on pumping speeds of altering various parts of the system, and to localise leak effects. Two recent notes have drawn attention to the possibilities as design aids of utilising the long-known analogy between rate of mass transfer under molecular flow conditions and current flowing in an electrical circuit. Aitken[17] describes an electrical analogue to the vacuum system of the Oxford 140-mev. synchrotron, which is a network made up of resistances in series and parallel (corresponding to tube parts of varying resistance to gas flow), with a voltmeter and ammeter and suitable switches, operated from 110 v. d.c. Stops[18] considers the more general case, and shows the analogous electrical circuit for a hypothetical vacuum system, in which resistors replace connecting tubes, condensers the volumes, and voltages correspond to pressures in various parts of the system.

Gauges

Beck and Brisbane[20] have described a magnetron-type ionisation gauge useful over the range 10^{-4} to 10^{-8} mm. Hg which is claimed to have as advantages over existing types a greater current output at a given pressure, and the elimination of electrical devices for stabilisation of the emission. The gauge may also be used as a leak detector with butane as a probe gas, when leak rates less than 10^{-6} lusec (litre-micron sec.$^{-1}$) can be detected, compared with 10^{-7} lusec which is the best claimed for the mass spectrograph leak detector. Conn and Daglish[21] have given a full description of a cold-cathode ionisation gauge utilising an axial magnetic field, which is claimed to be simple to make and operate and to be extremely resistant to chance damage. The normal useful range is 10^{-2} to 10^{-7} mm. Hg, but the gauge may be adapted for use at higher pressures.

A disadvantage of these cold-cathode magnetron-type gauges is that there is often a surge of gas on initial operation, undoubtedly due to clean-up of gases during previous operation by a mechanism which does not involve tight binding of the gas molecules. Brown and Leck[22] have studied this gas evolution using a mass spectrograph to investigate the nature of the gases. They conclude that the evolution originates from gas molecules (bound on the cathode surfaces by van der Waals' forces) being desorbed by impact of ions.



Hurd and Corrin[23] have designed a Langmuir-type viscosity gauge which, once calibrated against a McLeod gauge, may be used to record continuously the pressure of any gas of known molecular weight in the low-pressure region. The vibrating element is a molybdenum fibre carrying a small piece of iron wire at its lower end (to permit initiation of vibration by energising an external solenoid opposite the iron). This fibre vibrates opposite a fixed molybdenum strip with which it therefore forms a variable capacitance which is coupled in the grid circuit of a radio-frequency oscillator, thus imparting a frequency modulation. The natural vibration period of the fibre, which is damped by the gas present to an extent dependent on the pressure, is finally resolved as the frequency of an alternating-voltage output which may be fed to an automatic recorder.

With ordinary closed-limb mercury or oil manometers for medium degrees of vacuum, it is often tedious to fill the closed limb and to clean the manometer when required. Nester[24] suggests the use of a *Teflon* needle valve as the closure instead of the conventional sealed-off glass limb, which has the future advantage with his design that the mercury or oil can be readily degassed.

Leak detectors

Ochert and Steckelmacher[19] have presented a very useful survey of leak detection practice, with particular reference to the palladium leak detector, and have given a full list of references up to 1952 classified under the different types of detector. They discuss the relative advantages and disadvantages of the palladium-head ionisation gauge leak detector commercially developed as a versatile unit capable of detecting leaks of 10^{-4} lusec or less (Figs. 3 and 4). In principle, the plant under test is evacuated, finally with a diffusion pump, and probed with hydrogen; hydrogen enters at any leak, is transferred to the hot palladium-head of the gauge

[*Courtesy: J. Applied Physics*

Fig. 5. Designs of all-glass valves for use in ultra-high vacuum systems: (*a*) Sliding ground-glass valve; (*b*) Ball joint ground-glass valve; (*c*) Single slug glass valve.

through which it diffuses, and registers as a gas pressure inside the gauge.

General techniques

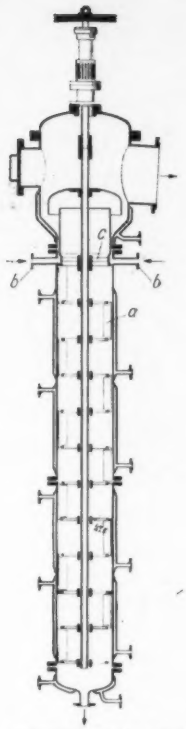
On vacuum systems in which mercury is used, it has been customary, where liquid air is not available for use with a cold trap, to use gold foil or sodium-potassium alloys to trap mercury vapour either to protect parts of the system from mercury or to protect the vacuum pumps. Gold is expensive, and the alkali metals are subject to rapid oxidation on contact with air. Heyding and Wood[25] have found that indium after heating for 4 to 5 hr. *in vacuo* to remove the oxide film is a more efficient getter for mercury vapour than gold, especially at higher mercury concentrations; that is, after some mercury has already been taken up by the surface. The indium amalgam is liquid over the range 18 to 42% Hg, therefore they suggest electroplating the indium on to fine brass gauze, the meshes of which delay the formation of amalgam drops. The indications are that the partial pressure of mercury over the indium at concentrations less than 18% Hg or less is 1/1,000th that of mercury at 25°C.

Wilson[26] has suggested the use of a mixture of methyl chlorosilane vapours (for example, from G.E.C. *Drifilm* SC77) to remove traces of water vapour in vacuum systems, particularly adsorbed water on glass parts difficult to flame out. After a few minutes in the system followed by re-evacuation, no evidence of adsorbed water could be obtained on letting known hygroscopic substances such as silicon tetrahydride into the system.

The formation of adsorbed layers in vacuum chambers, particularly metal ones, has been discussed by Koenig[27] in relation to their detection by electrons in electron microscopes and diffraction cameras. He emphasises that these adsorbed films, whose rates of growth are indicative of the quality of the operational vacuum, normally come from water vapour and hydrocarbon vapours (from oils, greases and rubber seals) in the residual gases.

Quarrington[28] reports that *Araldite* type 1, which is stated to have a vapour pressure of 10^{-7} mm. Hg at room temperature, can easily be used for bonding metals to glass. The joints after treatment at 200°C. for 1 hr. are capable of satisfactory performance even when immersed in liquid nitrogen.

A number of interesting designs of high-vacuum seal-off valves have appeared recently. Decker[29] gives three for all-glass valves capable of maintaining pressures of less than 10^{-9} mm. Hg for a week, the valves being operated by glass-enclosed iron slugs activated with external solenoids (Fig. 5). Richards[30] describes a seal-off valve which provides a permanent pumping tap on metal apparatus, capable of being used many times without soldering or welding. Fox[31] gives a design for a large reciprocating-action vacuum valve which is relatively simple to construct and obviates the very expensive large-bore glass taps. Brannen and Ferguson[32] claim that their simple universal vacuum joint, based on knife-edged stainless-steel flanges seated on expendible copper-rod gaskets, is capable of use at pressures of 10^{-10} mm. Hg.



[*Courtesy: Chemie-Ingenieur-Technik*

Fig. 6. Section through Sambay thin film evaporator (*for key to labelled parts see text*).

Vacuum distillation and evaporation

Rose and Rose,[33] in a review on distillation analysis, referred to work between 1951 and 1953 on the different types of columns in use for molecular distillation. It is suggested that all the designs of rotating-band columns then available were somewhat empirical, with no serious effort to predict clearances, rates of flow, etc., necessary for optimal performance. Schurig[34] has also recently reviewed high-vacuum evaporation and molecular distillation. A three-stage all-glass falling-film molecular still capable of giving better than one molecular plate separation with quantities of distilland less than 100 g. has been described by Sutton[35] as suitable for many biochemical and organochemical investigations. The liquid is distributed through sintered glass washers over the external surface of cylindrical tubes heated internally by refluxing solvents, the distillate from the first stage being similarly fed on to the tube of the next, and so on, and the combined distillands being fed back to the top of the still.

Schneider[36] has compared the merits of various types of thin-film evaporators which, originally designed for molecular distillation at 10^{-3} to 10^{-4} mm. Hg, are also useful in the range 10^{-1} to 10^{-3} mm. Hg. He discussed in particular the mechanical aids in maintaining the thin, uniform, free-flowing film which is necessary for commercial large-scale operation, and described two Continental commercial models—the Luwa and the Sambay evaporators—both of the free-falling type—in which liquid is fed on to the inner surface of a cylinder which is heated externally.

Fig. 6 shows a section through the Sambay evaporator. The product is pumped in at *b* on to the heated spinning distributor *c*, whence vapours escape through the holes and the liquid is uniformly distributed over the walls. The mechanically operated wipers *a*—which are of hardened steel, corrosion resistant if necessary, and may be of polyamide plastics for water and salt solutions which are difficult to smear—spread the liquid into uniform films the thickness of which depends on the throughput and viscosity of the liquid (0.1 to 0.2 mm. for water and 0.2 to 1.4 mm. for glycerine at throughputs 10 to 70 l./hr.). The distribution times vary from 3 to 20 sec. Exact dosing schedules are necessary to obtain good separations. The sizes of the evaporators vary from 50-mm. diam. on the laboratory model up to 600-mm. diam and 10-sq.m. evaporating surface. It is stated that the evaporators may be used to remove last traces of solvents, to pre-evaporate salt solutions to high concentrations, and also to obtain powders even in crystalline form.

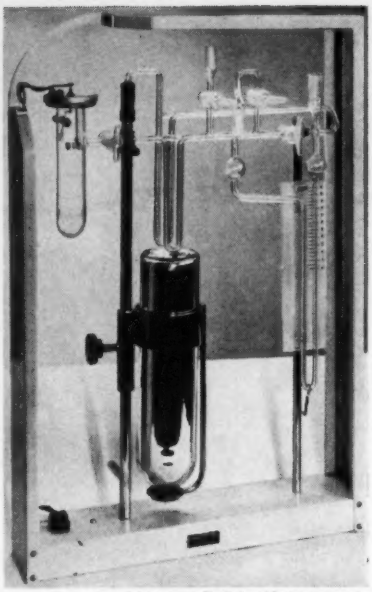
Vacuum drying

Reference has been made[37] to a new vacuum two-walled drier developed

in the U.S. for drying protein hydrolysates, molasses, coffee extracts and similar preparations, which is capable of reducing water content from 60 to 1% in 15 sec. The material is continuously fed as a film on to a steel band moving at 15 m./min. over two rotating drums—one 1.8-m. diam. heated internally, the other cooled with water. The entire assembly is in a vacuum chamber 2.6 × 2.6 × 4 m. which is evacuated by a three-stage steam ejector pump capable of handling 30 kg./hr. water vapour at 6.5 mm. Hg pressure.

Neumann and Matz[38] have reviewed the methods, principles and uses of freeze drying with particular emphasis on German equipment recently developed for commercial applications in medical and biological fields. Together with the books[1, 2] previously mentioned, this review emphasises the growing importance of such applications.

The pre-drying and degassing of capacitor paper has been discussed by Holland and Hackling[40] and of certain plastics by Holland,[39] both in relation to subsequent vacuum metallisation. For unlacquered capacitor paper, a unit was developed consisting of a cylindrical chamber 2-ft. long and 9-in. diam. in which rolls of the paper could be heated to 100°C. (above which there was evidence of paper decomposition). With a specially designed 'booster' oil vapour pump backed by a rotary oil pump operating on the gas ballast principle (to prevent condensation of water vapour inside the pump), eight hours' drying at 70°C. was generally sufficient. In the case of plastic materials, the majority were found to evolve large amounts of water vapour freely at low pressures. Thus pre-degassing at slightly elevated temperatures is necessary if metallisation is to be successful. Volatile plasticisers are to be avoided, otherwise they must also be removed by the drying process. As an outcome of this work, a simple apparatus has been developed for determining small amounts of water in materials[41] (Fig. 7). The specimen is continuously pumped through a dry-ice trap where the water is frozen out; when all the water is removed, the condensate in the trap is allowed to re-evaporate and the water vapour pressure measured on an oil manometer. It is stated that as little as 10^{-6} g. of water may thus be determined.



[*Courtesy: J. Scientific Instruments and Edwards High Vacuum Ltd.*

Fig. 7. Apparatus for determining small amounts of water in materials.

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Zeolite Manufacture Studied in Rumania

The Rumanian chemical industry has not yet taken up the manufacture of artificial zeolites and Rumanian chemists have studied the possibilities of making zeolites from imported raw materials. They found that the literature contains very few indications of the best conditions for the manufacture of zeolites, so they set out to study these conditions.

They decided to concentrate on the wet process, *i.e.* the precipitation of sodium aluminium silicate by mixing solutions of sodium silicate and sodium aluminate or aluminium sulphate. The materials required for making these salt solutions—bauxite, sodium carbonate, sodium silicate and sulphuric acid—are all available in Rumania. The zeolites obtained by this process have the formula

$$Na_2O.Al_2O_3.mSiO_2.nH_2O$$

where m is 3 or 4 and n, 4 or 5.

In order to find the best conditions for the manufacture of a zeolite with high ion-exchange qualities, the conditions of the experiments were varied as follows:

(1) The concentration of the sodium silicate solutions between 7 and 24%.
(2) The concentration of the sodium aluminate solutions between 4.25 and 12.7%.
(3) The proportion between silicon and aluminium between 3 and $4\frac{1}{2}$ mol. SiO_2 for 1 mol. Al_2O_3.
(4) The duration of the mixing process between $\frac{1}{4}$ hr. and 6 hr.
(5) The temperature during precipitation between 20 and 50°C.
(6) The drying temperature between 50 and 100°C.
(7) The *p*H value during precipitation.
(8) The *p*H value during drying.

The experiments were discussed in *Studii si Cercetari de Chimie* by M. Dima, El. Diaconescu, A. Carpov and E. Serban. The results appear to leave no doubt as to the possibility of manufacturing in Rumania, from indigenous materials, a zeolite whose water-softening power is as good if not better than the imported product's.

FILTRATION

Part I.—Fundamental Investigations

By H. K. Suttle, A.M.I.CHEM.E., F.R.I.C., M.INST.F.

(*Department of Chemical Engineering, Loughborough College of Technology*)

THIS account will deal with the removal of solids from liquids by the conventional methods of filtration, thus retaining the form of the previous reviews by Mr. E. L. Streatfield. However, it is considered desirable to extend the concept of the term 'filtration' and to include the removal of airborne dusts and aerosols, particularly as this topic is becoming of increasing importance in both industrial and urban life. The related operations of centrifuging and sedimentation are not reviewed here, although some reference to them will be necessary.

S. A. Miller[1] has presented his usual comprehensive review of this unit operation. The account is divided into the following sections: reviews; theory, experiment and design; process applications; equipment; prefiltration slurry treatment; filter media and filter aids; and ultrafiltration. In addition, photographs are reproduced of the Eimco pan filter and the new development of this company, the *Burwell* filter. Any other surveys of books or the literature of filtration have not come to the notice of the author.

Experimental work on various filtration phenomena

Porosity and its importance in filtration phenomena have again been investigated by Tiller.[2] In Part 1[3] of his published work, he has dealt with numerical methods for constant-rate and constant-pressure filtration based on Kozeny's law. In the present contribution, analytical equations are developed for constant-rate filtration. The procedure is based on the Kozeny equation, but is modified by taking into account the experimental data of Grace,[4] who has presented the results of a most outstanding experimental programme on resistance to filtration. It is characteristic of the work of Tiller in that he gives excellent worked examples of the method of computation. It is, perhaps, relevant to draw attention here to the work of K. Rietema[5] on the same subject, and to observe that, in the writer's opinion, these papers will have a profound effect on both the teaching and technology of filtration.

The term 'residual equilibrium saturation' is becoming familiar to students of chemical engineering.[6] It is that fraction of the voids of a packing which is filled with a wetting fluid under equilibrium conditions. The concept is of considerable importance in the treatment of filter cakes by air permeation, or by a second fluid, and was fully developed by Brownell and Katz.[7, 8] A recent article by Dombrowski and Brownell[9] deals with this phenomenon in relation to porous media. The extent of liquid saturation is obtained by an ingenious method developed by these investigators in which use is made of x-rays. A radiograph of the dry, porous medium constituting the test bed was first made, then the treated liquid was added and a second radiograph made of the bed now in a state of equilibrium saturation. The density of the two films so prepared was measured by means of a microphotometer. Thus a measure was secured of the point saturations. The heavy element chosen for these tests was iodine in the oils used, or lead salts in the aqueous solutions. The authors consider five conditions where the phenomenon may be encountered, and discuss their industrial importance. A general correlation is presented, and typical examples are fully worked out.

The hold up and residual saturation which results during the extraction of soya-bean flakes by gravity percolation has been described by Kocatas and Cornell.[10] The object of the investigation was to obtain data for the design of drainage beds used in this process.

The various phenomena observed in this complex subject have been described in a symposium convened under the chairmanship of Prof. J. Louis York, of the University of Michigan,[11] at which 12 papers were presented. Silverblatt and Dahlstrom[12] present a paper on the moisture retained by a filter cake consisting of fine coal. It is characteristic of these authors' work that detailed experimental results are presented, their interpretation is fully explained and, when feasible, a general application is suggested. In this paper, the statistical methods necessary for the interpretation of the results of experiments of this nature are described. Although it was considered primarily that surface tension might have controlling influences, the rather surprising result found is that viscosity is considerably more effective in reducing the water content of the cake. A general relationship is given which relates the moisture content of the filter cake to a multiple factor derived previously by Piros *et al.*[13] The procedure described should be applicable to other minerals.

In contrast to the phenomena associated with the removal of large amounts of solids by filtration are those associated with the parallel problem of removing small amounts of contaminants from large volumes of fluids. Cunningham *et al.*[14] publish experimental results for such a process, which have been obtained over a number of years using 18 different types of textile media. The filter media include cotton material in various forms, woven wool cloth, *Saran*, *Vinyon*, nylon, glass cloth and filter paper, and all these were submitted to test with air, water and oils. In the case of felted materials, and with air-flow rates up to 125 ft./min., the pressure drop ($-\triangle P$) in inches of water is given by the D'Arcy equation in the following form:

$$-\triangle P = k\mu v$$

in which μ is the viscosity of the fluid in centipoises, v is the superficial velocity in ft./min. and k is a constant for the material. In the case of felted cloths made of wool, rayon or cotton, the numerical value of k is found to be given by the simple expression $0.03\ W$, where W is the weight of the cloth expressed in oz./sq.yd. Similar experiments with liquids yielded data which, in general, conformed to the viscous flow equation given above. The wetting characteristics of the fluid toward the filter medium are of profound importance and it is considered that further investigation is desirable for a fuller elucidation of the problem.

Filtration of hot gases

Among the papers presented at a symposium on processes and equipment for air-pollution control[15] there is to be found a very practical account

by Snyder and Pring[16] dealing with the filtration of hot gases. The removal of particulate matter from the end gases of a manufacturing process is of great practical importance to the chemical engineer and the process engineer. Especially is this the case when the gases are corrosive or the material recovered has considerable monetary value. On the other hand, if there is little or no value in the solids, the operation is a distinct contribution to the prevention of atmospheric pollution.

The development of synthetic fibres during the past 15 years has contributed largely to the return to favour of the bag filter. A modern bag-filter plant is a continuous, automatic unit which operates at a high recovery efficiency. Indeed, the standard aimed at is to employ only those fabrics which will ensure a collecting efficiency of at least 95%. The outstanding fields of use are, perhaps, those in which hot gases from metal-producing furnaces and direct-fired driers are treated, and where the initial gas temperature may be as high as 2,000°F. It therefore becomes necessary to cool the gas before admittance to the bag-house. This temperature is such that it is well above the dew point of the gas mixture, but is not so high a value as to bring about deterioration of the fabric. The temperature recommended is 75 to 100°F. above the dew point.

The considerations which govern the selection of the filter medium may be listed as follows: gas temperature and its composition, dew point, particle size and properties of the solids or fume to be collected. The ideal material for this purpose would possess the following properties:

(1) It would be unaffected by gas temperatures up to 450°F. whilst, at the same time, it would retain its chemical stability and dimensional stability.

(2) It would possess the tensile strength and resistance to flexing which is normally associated with ordinary cotton fabrics at normal temperatures.

(3) It would possess a reasonably high permeability yet be retentive to the dust and, in addition, it should retain a light residual dust load after shaking.

In a discussion on the cloth area required for this type of apparatus, the authors refer to the work of Williams *et al.*,[17] who state that ' filter resistance comprises the sum of the resistances to air flow of the filtering medium and of the accumulated layer of particles on the surface of the cloth, which affects a major portion of the filter action of the apparatus.' Further, at the filtration velocities commonly encountered, the flow through the cloth is streamline and, therefore, the resistance is a linear function of velocity. Thus, for clean air,

$$R_i = K_o V$$

where R_i is the initial filter resistance in inches w.g.; K_o is the permeability constant for the filter medium, including any residual dust (this value is always determined with clean air and is expressed as in. w.g./cu.ft./min./sq.ft./min.); and V is the filtration velocity, expressed as ft./min. or cu.ft./min./sq.ft. of cloth. It may be termed the air-to-cloth ratio.

At the end of a given operating period, the resistance will have risen to a maximum value which may be expressed by

$$R_f = R_i + R$$

where R_f is the maximum resistance in inches w.g.; and R is the increase in filter resistance during the time of operation T, and the value of T is the time in minutes required to bring about the value of R inches resistance.

Williams and co-workers applied to gas filtration the relationships used for the filtration of fluids through granular beds, and suggested that

$$H = \left[\frac{k}{g} \cdot \frac{\mu}{\rho} \cdot \left(\frac{A}{V}\right)^2 \cdot \frac{1-\delta}{\delta^2} \cdot \frac{1}{\rho_o}\right] \frac{v^2 L t}{7{,}000}$$

which implies that the filter resistance (H) is a function of the kinematic viscosity (μ/ρ) of the gas. If it may be assumed that the variables enclosed within the brackets are constant for any given aerosol, the expression may be simplified to read as follows:

$$R_f - R_i = \frac{K_1 L T V^2}{7{,}000}$$

which suggests that (*a*) for any aerosol, R is a linear function of the group (LTV), namely the weight of dust per sq. ft. of cloth; (*b*) K_1 is independent of cloth characteristics; and (*c*) K_1, and consequently R, is a linear function of the kinematic viscosity.

In the above expressions, H is the increase in filter resistance due to dust load, expressed as feet of fluid (in this case feet of air); k is a constant depending on particle shape and surface properties of the dust (it is dimensionless); g is the gravity constant, expressed in English units; L is the dust loading in the air prior to the filter, in gr./cu.ft.; t is the time in seconds required to attain H ft. of resistance; v is the average filtration velocity in ft./sec.; V/A is the ratio of volume to surface area of the particles on the filter (ft.); δ is the porosity of the filter bed (*i.e.* volume of voids divided by bulk volume of deposit); ρ is the density of the gas, in lb./cu.ft.; ρ_o is the real density of the dust particles, in lb./cu.ft.; μ is the viscosity of the gas, expressed in English units; and K_1 is the specific resistance or resistance factor of the deposit. This last is expressed in in. w.g./lb. dust/sq.ft. cloth area/ft./min. filtering velocity. Permeability is defined as the air volume per sq. ft. of cloth at a pressure of ½ in. w.g.

Tests and values of the filtration constant (K_1) are reported for *Orlon* filter fabrics. The authors state that three filter fabrics are in common use for the treatment of hot gases. These are wool, *Orlon* acrylic fibre and *Fiberglas*. Wool is moderately resistant to acid gases and will withstand temperatures up to 215°F. *Fiberglas* can be used up to 450°F., but possesses poor flexing resistance. The limiting temperature for *Orlon* is 275°F., but otherwise it fully satisfies requirements (1) and (2) mentioned above. '*Orlon*, at present, enjoys a wide popularity for hot gas filtration.'

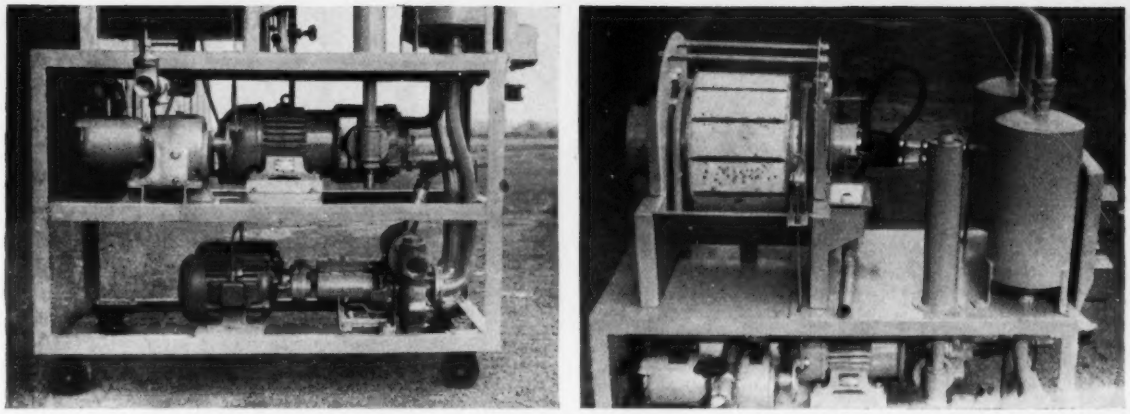
Electrostatic charges

Electrostatic charges on fabrics used for the filtration of air is the subject of a most interesting account from the Harvard School of Public Health[18] by Silverman *et al.*, who describe experimental work designed to demonstrate the phenomenon of a mechanically induced electrostatic charge on selected fabrics and the effect on air filtration. The electrostatic mechanism of filtration is also presented, as it applies in this case. The phenomenon is termed ' frictional ' or ' tribo-electrification.' The fabrics tested are wool, resin-treated wool, acrylic fibre (*Orlon*) and *Saran*. Atmospheric dust was used as the test aerosol. *Saran* is notable in that it retained a very high charge due to this mechanical action, and it is concluded that synthetic fibres can be charged to a much greater extent than natural fibres.

Of greater interest to the chemical engineer, however, is the influence of humidity on the magnitude of the charge induced. The charge disappears completely, with all materials, when the absolute humidity exceeds 120 gr. of moisture per lb. of dry air. The account concludes with a list of 29 references.

Other experimental work

Particle size analysis continues to hold the interest of several investi-



A laboratory, vacuum, drum filter used in the Chemical Engineering Department of the Loughborough College of Technology. In the view of the lower decks (*left*) can be seen the vacuum pump, agitator control and Sigmund, direct-coupled, centrifugal discharge pumps. The view on the right shows the filter drum, pressure and vacuum lines and filtration receivers. Eimco (Great Britain) Ltd. supplied the filter.

gators, with special application to centrifugal sedimentation methods. Donoghue and Bostock[19] have presented a full account of apparatus evolved by them for this purpose and report experimental results in the size range 0.7 to 1.5 microns. The reproducibility of the method of test is demonstrated. The theory of centrifugal sedimentation is given in some detail and a useful list of modern references concludes this contribution.

A rapid general-purpose method, based on the same principles, is presented by Whitby.[20, 21] The apparatus and theoretical bases are given, and it is claimed that the method has undoubted value for measuring the size distribution of dusts in the range of 0.05 to 100 microns.

An apparatus which automatically records the sedimentation of powders finer than 74 microns is described by Yagi.[22, 23, 24] The powder is homogeneously suspended in a medium of such a density and viscosity that Stokes' law is obeyed. Differentiation of the recorded sedimentation curve yields the particle size distribution.

The problem of the measurement of the concentration and particle size of aerosols is demonstrated in an interesting account by Sinclair,[25] who uses two light-scattering chambers with phototubes so arranged that the scattering is a measure of concentration. Richardson and Wooding[26] discuss the use of a sedimentation cell for the purpose of sampling aerosols, and show under what conditions a reliable sample is likely to be obtained.

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New and improved filters, media and ancillaries, and applications of filters to chemical and cognate processes, will be described and illustrated in Part 2 of this review.

The Leonard Hill Technical Group—December

Articles appearing in some of our associate journals this month include:

Paint Manufacture—Stearates for the Paint Industry, 1: Fundamental Properties; The Evaluation of Aluminium Pigments, 2; Isocyanates for Surface Coatings; Particle Size: A Report of a Recent O.C.C.A. Lecture.

Food Manufacture—The Touch of the Dutch: A Food Technologist Visits the Netherlands; Microscopical Technique for the Food Analyst; Dehydration of Fruit by the Vacuum Contact Plate Method; Why Cooked Potatoes Blacken; Milk, Cereals, Fermentation Processes; Raising the Status of Canned Vegetables; Recent Advances in Starch Chemistry; Bottled Mineral Waters in Italy: Notes by a Critical Tourist.

Manufacturing Chemist—Extraction of Cholesterol from Wool Wax Alcohols; Silicones in Polishes; Vanillin; International Process Licensing; Industrial Safety; Progress Reports: Hormones, Analytical Chemistry, Antibiotics.

Fibres—Society of Dyers and Colourists' Symposium, Part 2; Fibre Rope: Safety Codes of Working; Vehicle Operation in the Fibres Industries; 5,000 Years of Fibres and Fabrics.

Petroleum—Stores Operations in the Oil Industry Overseas; Plant Calculations for Petroleum Technologists, 3; Thames-side Oil Refineries.

Corrosion Technology—Electrical Deaeration of Feedwater; Corrosion Studies Aid Light Metals; Selection of Bolt Materials for Underground Service.

Atomics—Chemical Operations with Fissions Products Solutions; Gas Counting Techniques in Biochemistry, 2.

Dairy Engineering—Report from the Dairy Show; Six Million Ices a Day; Ice Cream Production and the Dairy Engineer; Heated Words from the Ice Cream Conference; Linings for Mild-steel Milk Tanks.

A New Phase of Development in INDIA'S CHEMICAL INDUSTRY

(Specially Contributed)

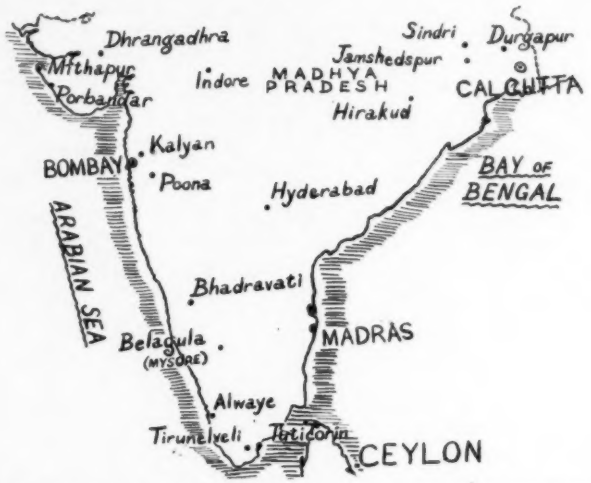
The chemical industry in India has sprung up from comparatively small beginnings to a sizable stature in recent years. The First Five-Year Plan of India, inaugurated four years back, was primarily concerned with agriculture and irrigation, but also gave considerable incentive to chemical manufacturers, especially in the fields of heavy chemicals and fertilisers. This article briefly reviews the major developments and focuses attention on the potentialities that lie ahead of the Indian chemical industry in the immediate years to come.

Dyestuffs

WITH an immense textile industry in India, dyestuffs naturally occupy a big place. The annual requirements of dyestuffs are estimated at 22 million lb. and the greater part is met through imports. During 1954, India imported 14,314,100 lb. of dyestuffs, valued at Rs. 151,303,620, from the United Kingdom, the Continent and the United States. The manufacture of dyes in India was first started by the Associated Research Laboratories as early as 1940 and since then several firms have entered into the manufacture of stabilised azoics and developing salts. The total production in India in all units of azodyes, fast colour salts, solubilised vats, stabilised azoics and sulphur black in 1953 amounted to some 1,571,701 lb., whereas the figure for 1954 stood at 3,577,331 lb. The production during the current year is not yet known.

The raw materials in many cases are imported. The policy of the Government of India has hitherto been to permit liberal imports, but of late this has changed to encourage manufacture of such varieties as can be wholly or partly produced in India. The Indian Tariff Commission have looked into the question of protection to the dyestuff industry in India and have recommended protection for a period of 10 years subject to periodical reviews. The Government of India have accepted the recommendation. It is learnt that the industry would be in a position to meet nearly 70% of the indigenous needs by the close of the Second Five-Year Plan in 1960.

In the meanwhile, Atul Products Ltd., Bombay, entered last year into an agreement with Imperial Chemical Industries Ltd. for the joint manufacture of certain dyestuffs with a capital outlay of Rs. 10 million (£750,000), of which about half will be provided by I.C.I. together with technical assistance and marketing help.



Map of India, showing the locations of some of the plants mentioned in this article.

A new company, Amar Dye-Chem Ltd., was formed last year in Bombay for the manufacture of dyes of the naphthol series, fast bases, stabilised azoics and the necessary intermediates. The company has entered into an agreement with Hilton-Davis Chemical Co., of Cincinnati, Ohio, according to which the U.S. firm will supply technical know-how and provide trademark rights. A modern factory near Kalyan, with a cost of Rs. 10 million, is well under way.

It is reported that the Government of India have before them a number of applications for dye manufacture in collaboration with German and American interests. It is learnt that Tatas are interested in this industry and in setting up a plant in Jamshedpur. The Government of India appear to hold the view that a scheme should be evolved for utilising the waste gases of oil refineries and steel factories in the manufacture of dyestuffs.

Heavy chemicals

There are eight units in India manufacturing caustic soda by the electrolytic process with an installed capacity of about 30,600 tons, while the actual production has been around 14,500 tons only. The annual demand is estimated at about 60,000 tons and imports go to meet a substantial part of the country's needs. With the First Five-Year Plan it was hoped to raise caustic production to 33,000 tons by 1956. The Development Council for Heavy Chemicals (Alkalis), inaugurated a few months back, expect the capacity to be increased to 106,000 tons p.a. through 10 new schemes.

In this connection it may be interesting to list some new ventures which are coming up to augment the production of caustic soda in the country. The facilities of Heavy Chemicals

Ltd., at Tuticorin, South India, are making rapid progress. The factory will produce, during the first stage, 5 tons/day of caustic soda and all the by-product chlorine will be utilised in the manufacture of high-test hypochlorite. In the second stage, the caustic soda production will be stepped up to 10 tons/day and the surplus chlorine is to be used in chlorinating ilmenite to make useful products.

There is a proposal to set up another factory in the area with a daily production of 65 tons.

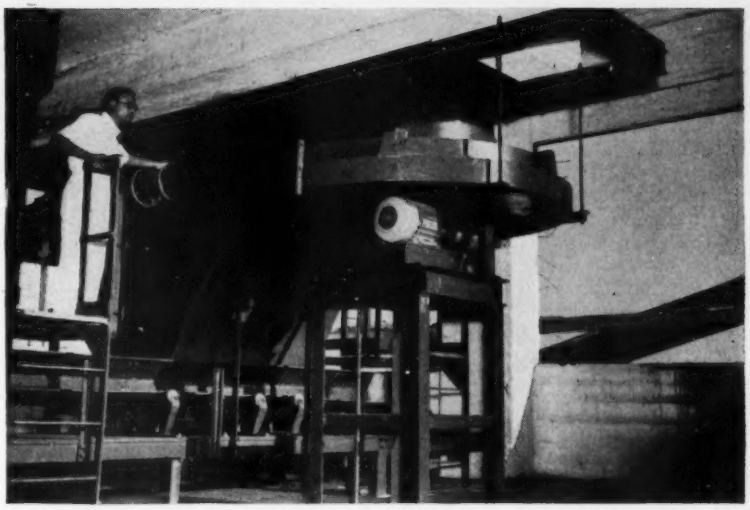
A new plant for manufacturing caustic soda may be set up at Indore at a cost of Rs. 6 million (£450,000), of which about half the amount will be used to purchase plant and machinery abroad. The new plant will have a capacity of 11¼ tons/day of rayon-grade caustic soda.

It should be remarked here that production of rayon-grade caustic is only being undertaken by Travancore Cochin Chemicals Ltd., Alwaye. The National Rayon Corporation have drawn up plans for caustic soda manufacture.

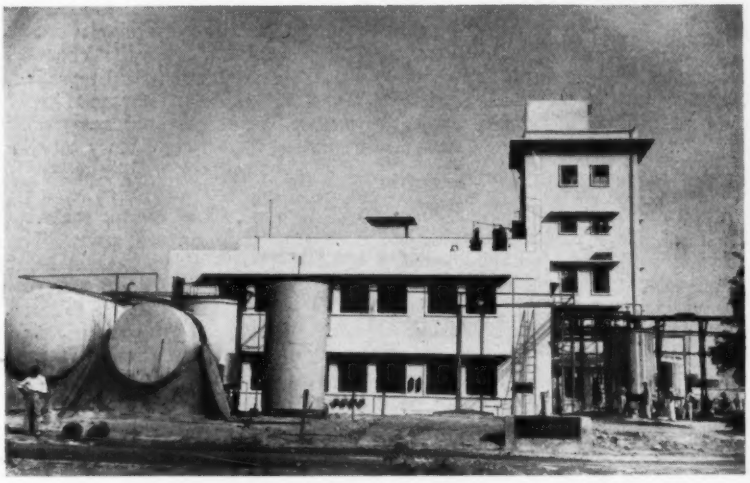
For bleaching powder manufacture, there are two units in India with an installed capacity of 8,170 tons p.a., while actual production has been less than 2,000 tons. One of the producers, the Mettur Chemicals & Industrial Corporation Ltd., Mettur Dam, South India, is currently engaged in the erection of a new stable bleaching powder plant. The plant is expected to be ready before the close of the year, will take the company's total production to about 6,000 tons p.a. and will meet substantially the demand for this chemical in India.

About 7,000 tons of liquid chlorine are manufactured in the country, as against an installed capacity of 15,100 tons. Disposal of even the present output of chlorine presents a problem. The Development Council for Heavy Chemicals (Alkalis) has set up a special committee to deal with the problem.

The marketing of caustic soda ash will be done, according to a recent Government scheme, through controlled monopoly vesting in Tatas and Imperial Chemical Industries. The firms will be paid fixed remuneration for marketing work, while imports will be arranged for by the Government. On the basis of a recommendation by the Tariff Commission, the Government of India have announced early this year protection to the indigenous caustic soda and bleaching powder industry for a period of four years. The imports of caustic soda will be licensed to actual users and established importers.



Motor-driven blending tables in coal preparation section of Sindri coke oven plant.



DDT factory at Delhi, with acid tanks on left.

That there is need to bring down the price and improve the quality of soda ash has been brought out by the recent Tariff Commission enquiry into the soda ash industry in India. The outputs of the two units manufacturing soda ash—Tata Chemicals Ltd., Mithapur, and Dharangadhra Chemical Works, Dharangadhra—have nearly been doubled during the past few years. The Planning Commission anticipates a demand of 155,000 tons by 1956. Among plants through which the country's production may go up in coming years, mention should be made of a new plant proposed by Birlas at a cost of Rs. 50 million (£3,750,000). The plant to be located at Porbandar in Saurashtra will have an initial capacity of 100 tons/day, capable of being stepped up to 200 tons/day. The Industrial Credit & Investment Corporation, an agency formed through pooling the resources of the World Bank and investors in the United Kingdom, the U.S.A. and India to promote the private sector, would advance a loan and also provide facilities for stabilising the plant. Dharangadhra Chemicals are reported to be interested in setting up a soda ash plant in South India.

DDT manufacture

The first State-owned DDT plant near Delhi, which was set up in 1952 as a joint venture by the Government of India, the World Health Organization and United Nations Children's Emergency Fund, was taken over last

year by a private registered company, Hindustan Insecticides Ltd. It was recently announced that the first batches of DDT have passed chemical tests and that normal production of about 2 tons/day has started. The U.N.C.E.F. has allocated a sum of $275,000, which will help to double the production to a target of 1,400 tons p.a. The supplies will be used by the State Governments in anti-malaria operations. Meanwhile, the Production Minister of the Government of India has just stated that another DDT plant may soon be started somewhere in South India with a capacity of 1,400 tons p.a.

Penicillin

A penicillin factory at Pimpri, near Poona, was commissioned recently and the first product has been put on the market. The factory will be managed by Hindustan Antibiotics Ltd. The factory was designed to produce about 20 million mega units p.a. of penicillin. A committee of 10 experts very recently recommended far-reaching recommendations, and the Production Ministry of the Government of India have accepted these recommendations for early implementation. The production of the factory will be stepped up and also diversified. The expanded annual production would be up to 32 million mega units of penicillin p.a. It has been decided that manufacture of bicillin should be taken up at the factory. Steps are being taken to siliconise glass vials at the bottling plant in Bombay. The committee favour manufacture of potassium salt, as it is less hygroscopic and also cheaper than the sodium salt. Other recommendations include dispensing of procaine penicillin, benzathine penicillin and BBED penicillin. The factory has plans for expansion in the years to come to produce streptomycin and chloromycin.

Fertilisers

The setting up of the Sindri fertiliser factory has contributed immensely to chemical fertiliser production in India. According to a report of the Development Council for Heavy Chemicals (Acids and Fertilisers), the requirements of various nitrogenous fertilisers in India by 1957 would be about 173,000 tons p.a. of nitrogen. With a projected internal production of 109,000 tons there would be a deficit of about 64,000 tons. The Council is planning to increase production by another 100,000 tons p.a. of nitrogen, as consumption is expected to increase considerably by then.

The Sindri fertiliser factory has reached target production with about 1,000 tons/day, the output for a recent month having been 25,620 tons of ammonium sulphate. The other factories producing the chemical are Fertilisers & Chemicals Ltd., Travancore, and the Mysore chemical works at Belagula. Sindri will be expanded considerably in scope. The Government of India, according to a recent communique, have approved the expansion programme to produce 70 tons of urea and 4,000 tons of ammonium sulphate-nitrate mixture per day, but utilising the entire quantity of 10 million cu. ft. of gas from the coke-oven plant. The project, estimated at Rs. 10 million, has been entrusted to the Italian firm of Montecatini, Milan. The Government of India have also appointed a Fertiliser Production Committee to make recommendations for the additional capacity of nitrogenous fertilisers. Two new fertiliser factories have been proposed; one at Bakra Nangal, where the chemical would be produced as a by-product in the manufacture of 10 tons of heavy water required for atomic energy work in India. The other factory may be located in South India.

Fertilisers & Chemicals Ltd., Alwaye, South India, have started a new ammonium chloride plant. The plant is the first of its kind in India and has a capacity of 8,000 tons p.a. The plant has been designed to make use of by-product hydrochloric acid from the adjacent facilities of Travancore Cochin Chemicals. Straight neutralisation with ammonia in saturators and centrifuging the slurry yields ammonium chloride. The chemical will meet the needs of the dry-cell and other industries consuming about 4,000 tons p.a., and can also be used as a fertiliser.

In the matter of superphosphates, 14 factories in India produce about 150,000 tons p.a., which is only 3% of the phosphatic fertiliser requirements of the country, according to a recent survey of the Economic Commission for Asia and the Far East. There is enormous scope for the development of phosphatic fertilisers in India. In this connection, mention may be made of efforts to utilise by-product hydrochloric acid to digest phosphate rock in an attempt to overcome the sulphuric acid shortage; however, owing to the highly deliquescent calcium chloride formed, the product has not been found suitable.

In another work, phosphate rock has been fused at about 1,300°C. along with fluxes to bring phosphorus into the citrate soluble form; a fertiliser containing about 15% citrate soluble P_2O_5 has been prepared and is claimed to yield good results. At the National Chemical Laboratory, Poona, the thermal decomposition of phosphate rock by magnesium salts of sea bitterns from Tata Chemicals has been tried at a temperature of 700°C. and a period of 2 hr. This resulted in converting about 80% of the phosphorus present into citrate soluble form.

Epsom salts, a by-product of the salt industry, have been used as a substitute for gypsum in the fixation of ammonia and in the production of N-K fertilisers. By the action of ammonia and carbon dioxide on a saturated solution of epsom salts in presence of potassium chloride and a single crystallisation, ammonium sulphate of 99.6% purity has been obtained. The unreacted epsom salts separate out as ammonium schoenite $MgSO_4(NH_4)_2SO_4\ 6H_2O$, itself a useful mixed fertiliser. The overall fixation of nitrogen is over 90%.

Steel plants

Three new steel plants have been reported to be established in India with German, Russian and British assistance. It has been disclosed that a fourth steel plant might also be set up in the near future. The total production in the second plan period may be taken up to 4½ million tons. It was recently stated that India would have 10 steel plants in the next 20 years.

The Government of India have concluded an agreement with the German firms of Krupps and Demag to form a new company styled Hindustan Steel Ltd., with a capital of Rs. 1,000 million (£75 million), the Government contributing four-fifths of the share capital. The contribution of the participating firms will be in the form of equipment. The plant will produce initially 720,000 tons of steel, according to recently revised estimates, and the capacity will be stepped up to 1 million tons p.a. in due course. The technical experts selected a site, Roerkela, in Orissa, very near the source of the raw materials, while power would be available from the Hirakud project; coal will be transported from Bengal. The erection of the plant is fast going ahead.

The Soviet Union, a year or so ago, offered to erect another steel plant in India to produce 750,000 tons of steel, and indicated advancing of a loan at a rate of interest roughly half of that of the World Bank. Subsequent to a visit of technicians, a site in Madhya

Pradesh, Bilhai, has been chosen where work is going on now and production is expected to start in 1958.

Meanwhile, British steel interests, in co-operation with Birlas, offered to set up a third steel plant in India. The scheme did not at first find favour, but now the Government have decided to accept the offer. After the visit of a team led by Sir Eric Coates, Durgapur in West Bengal has been chosen as the site for setting up the plant. The plant will have a capacity of 750,000 tons p.a. and will be integrated with other development works in that State regarding coke, gas and chemical production.

The expansion programme under way at the Tata Iron & Steel Co.'s works at Jamshedpur would bring the company's total capacity by 1958 to 1.3 million tons of ingots, and the new expansion project would involve the creation of an additional 700,000 tons of capacity. The company had successful negotiations with the World Bank and the Export Import Bank in the United States for a loan of Rs. 300 million (£22½ million).

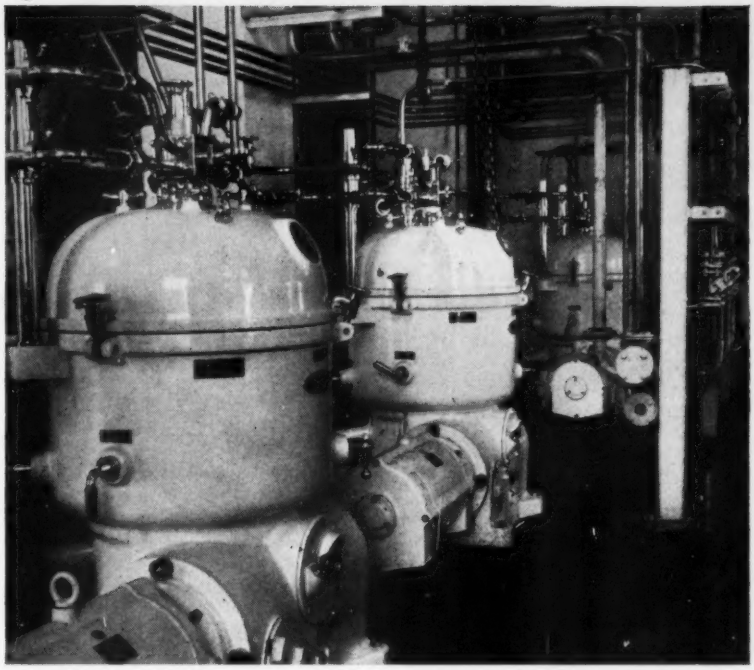
The Mysore Iron & Steel Works at Bhadravati, the only charcoal iron plant in India, will step up its production in the Second Five-Year-Plan period to 100,000 tons p.a. Besides 30,000 tons of ferro-silicon, 2,000 tons of tool steels will be produced; the second electric pig-iron furnace will go into production shortly.

From the above developments, it will be seen that the basic steel industry of India will gain a huge impetus in the next few years.

Coke ovens

A new battery of coke ovens was commissioned late last year, together with by-product recovery plants at the Sindri fertiliser factory. Built at a cost of Rs. 2½ million (£187,500), the battery has been financed from Sindri's own resources. While about 150,000 tons of hard coke and about 100,000 tons of soft coke had been produced annually hitherto, the new ovens will produce nearly 200,000 tons p.a. of coke. There will be complete recovery of benzole and other by-products.

Another battery of coke ovens was added to the Tata Iron & Steel Co. some time ago, while a new project has just been formulated to have a coke plant, a gas distribution grid and a 60,000-kw. power plant at Durgapur at a cost of Rs. 120 million (£9 million). The latter is an integrated scheme visualising, in stages, production of coke for metallurgical, industrial and domestic uses, complete gasification of coal for the synthesis of ammonia, fertilisers, explosives and oil, and power generation. A modern 100-tons/day tar distillation plant will be established and 3,500 tons of carbon black will be produced p.a.



View inside penicillin factory at Pimpri, near Poona, showing Lurvesta extractors.

The lignite reserves of Neiveli, Madras State, will be exploited. The British firm of consulting engineers, made available under the Colombo Plan, after a thorough survey have recommended six alternative schemes, ranging in outlay from 350 to 850 million rupees. A scheme costing Rs. 580 million (£43½ million) has finally been chosen under the joint responsibility of the Government of India and the Government of Madras State. The scheme aims at mining 3¼ million tons of lignite, generating 200,000 kw. of power, and factories to produce 200,000 tons of ammonium sulphate and 350,000 tons of carbonised briquettes, together with the possible production of coal and by-product chemicals. A new discovery of a 12-million-ton reserve of lignite was made last year at Umarsar, Kutch. Though a few more deposits of lignite are known to occur in India and some are being worked, the Neiveli deposits will receive immediate attention in view of the lack of coal resources in South India.

Other new chemical plants

The Birla Jute Manufacturing Co. has started a new calcium carbide plant at Birlapur near Calcutta. The plant, which is the third in India, will have a production of 7½ tons/day and a rated capacity of 10 tons. The demand for the chemical is around 8,000 tons p.a., which is primarily met from imports. There are two units, one at Tirunelveli (Madras) and another at Kottayam (Travancore). The Central Electrochemical Institute at Karaikudi, South India, has found that carbonised briquettes from Neiveli lignite are suitable for the manufacture of calcium carbide.

A modern factory with a rated capacity of 60,000 lb. of quinine sulphate and 30,000 lb. of other cinchona alkaloids was commissioned on the Anamallais a few months back. There are large cinchona plantations in the area and there has been for over two decades a factory capable of producing 20,000 lb. of quinine sulphate and 10,000 lb. of cinchona alkaloids p.a. The new factory is an addition to the existing one and the production will go to combat malaria in India.

The Indian Atomic Energy Commission are understood to be constructing chemical plants for the extraction of thorium and uranium from Indian ores. It may be added that there is already one plant, that of Indian Rare Earths Ltd., in Travancore, which processes monazite.

New Russian Vibro-Disintegrators

ENTHUSIASTIC reports have appeared concerning some new developments in vibrator grinding mills in the Soviet Union, these machines now being widely used in the most varied fields for fine grinding, including the building industry and many branches of chemical and related manufactures.

In an account which has been given in the Soviet journal *Mekhanizatsiya Stroitel'stva* (August 1955) by M. Ya Sapozhnikov and R. V. Kugel, the emphasis is mainly on building materials such as sand, limestone, etc. There are the comparatively simple models M200-1.5 and M200-3, also M10, laboratory size, and then a complete grinding unit that includes fans, classifiers, etc. The former comprise a cylindrical body, a vibrator, spring suspension, supporting frame, electric motor and flexible coupling. The vibrator consists essentially of one tube disposed over another, with water circulating between to cool the bearings, and mounted on a debalanced shaft. This latter is either whole or sectional and, when rotated, the body oscillates with a frequency depending on speed, averaging about 25 hertz for the 1.5 and 50 hertz for the 3 model.

Some parameters of the two mills include frequencies (1,500 for 1.5; 3,000 for 3); amplitudes, 3 and 2 mm.; and debalance moment of shaft in kg./cm., 140 to 175 and 65. The actual grinding elements are either steel balls or rollers weighing 740 kg., or porcelain balls of 240 kg. The mills may be used for dry or wet grinding.

Dry grinding arrangement

A layout for dry grinding has been suggested, with supply and measuring hoppers and ducts, and a high-pressure fan for forcing air into the mill to remove partially ground material from the grinding elements to the classifier. Here the fine particles separate and settle in a cyclone, whilst the coarser are returned to the mill. Output of sand or sand-limestone mixes, with 95 to 98% passing 100-mesh/cm. sieve, is about 260 kg./hr., having specific surface of 4,000 to 4,500 sq.cm./g.

In a variation of this unit, the partly ground material is not blown from the surface of the balls or rollers but expelled from the mill into a duct where it is picked up by an air blast and conveyed to a classifier. In some cases, as with cement grinding, the pneumatic classifier is omitted. Different forms of the mill and set-up have been thoroughly tested in laboratory and works, with special reference to amplitude of oscillation, power required, circulation of grinding elements or balls, their weight, etc.; as well as the efficiency of the mill with various materials of different degrees of fineness, its working life or stability, heat evolved and ease of repair.

Strength and endurance tests

Unlike other grinding mills, these vibro-disintegrators can only to a very limited extent be enlarged or strengthened in whole or in part to take greater strains. In such machines fatigue and breakdown of certain units or parts thereof must be a serious problem. A formula is given relating stress in a component with length of working life until breakdown through fatigue:

$$N = \left(\frac{A}{\sigma}\right)^m$$

where N = number of cycles before breakdown, σ = stress, A = constant (coefficient) and m = power index characterising angle of slope of fatigue curve in logarithmic co-ordinates.

Owing to the multiple or power relation (m) between stress and working life, a small change in the former makes a very considerable difference in the latter. Fatigue tests among individual items of the same batch of components—ball and roller bearings, springs, bolts, etc.—have given widely divergent results, emphasising the need for examining these in fairly large numbers to get a reliable average.

In considering other factors governing the strength and endurance of the different components, it has been found, as engineers will appreciate only too well, that each model has its own individual peculiarities, owing to various causes. These may or may not facilitate satisfactory test results. This same variability, as seen with fatigue tests and results, is also found in connection with the wear of different parts, though to a lesser degree.

All this points to the need for testing a large number of models and, in the case of these vibrating disintegrators, the number has been over 80, with special tests under exceptionally severe conditions—up to 1,000 or 1,200 hr. As a result, considerable improvement has been effected in the matter of fatigue resistance and length of working life. Even a seemingly small change in design, such as the form of openings (*e.g.* discharge outlets)—or type of welding used for these, whereby concentration of stresses was eliminated—made a big difference in strength and stability. Some models of industrial size worked more than 6,000 hr. (about 10^9 cycles) without any sign of fatigue effects. Further improvement was effected in which welding of the vibrator bodies was avoided and premature breakdown completely absent.

Other improvements made later include ball-bearing 'separators' or bushes in which the stamped iron separators were replaced by brass; various joint connections were strengthened, *e.g.* between vibrator and mill, to eliminate clearances or loose play; and the spring supports of the machine —which at first were in the form of gas-filled rubber spherical bags—were replaced by cylindrical springs, several of which, relatively small, were disposed in series under the sides of the frame. They were, in fact, automobile engine valve springs, shot blasted to increase fatigue resistance. To reduce wear on inside of mill when grinding abrasive material such as quartz sand, replaceable linings were used.

Testing of each new model was done in two stages: (1) determining the optimum regime of grinding (oscillation range, amount of charge, wet or dry grinding, batch or continuous, with or without classifier, etc.); and (2) determining output and power required for a given material ground to a given fineness under each regime. All the work so far done must be regarded as a preliminary stage in the development of a new technique in fine grinding, and further experiments are in hand including larger machines.

To Authors

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to *The Editor*, CHEMICAL & PROCESS ENGINEERING, *Stratford House*, 9 *Eden Street*, *London*, *N.W.*1.

In addition, the Publishers and Editors of the Leonard Hill Technical Group are always ready to consider technical and scientific manuscripts with a view to publication. Correspondence should be addressed in the first instance to the Book Production Manager, at the above address.

Terramycin Manufacture in Britain

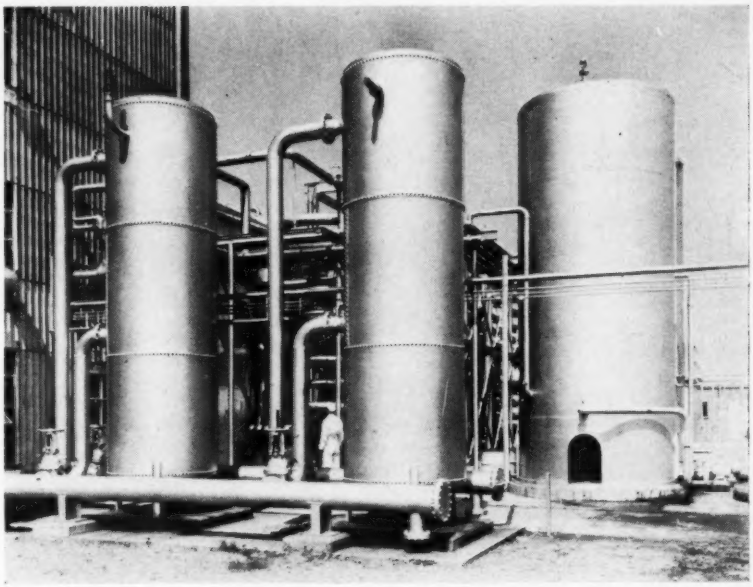
PFIZER'S NEW DEEP-FERMENTATION ANTIBIOTICS PLANT

TERRAMYCIN, the broad-spectrum antibiotic which has previously been produced only in the United States, is the principle product of a £2½-million plant which was opened at Richborough, near Sandwich, Kent, recently. The plant is owned and operated by Pfizer Ltd., the British subsidiary of Chas. Pfizer & Co. Inc., of the U.S. The subsidiary company, which has been established in Britain only just over three years, has been processing imported Terramycin in its Folkestone factory since 1953. Even as this plant was brought into operation, plans were being laid for the new fermentation plant.

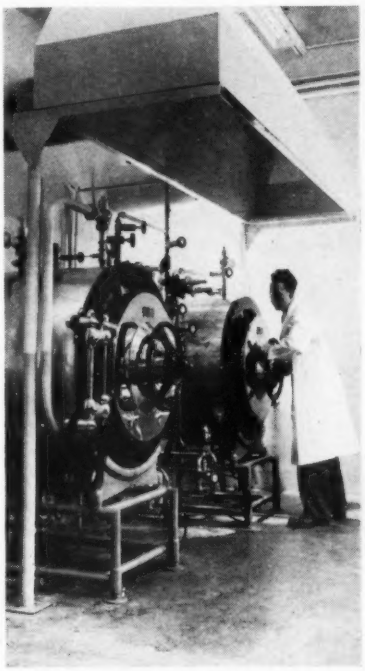
The site selected consists of 80 acres located on a navigable river with a wharf. Existing buildings were utilised. The building of the plant and the manufacture and installation of equipment was carried out entirely by British firms. The work was done so speedily that it was possible to commence fermentation on a production scale only nine months after the beginning of constructional work on the site.

The plant buildings cover 120,000 sq. ft. and contain 32 miles of cable, 33 miles of piping, almost 300 tons of structural steel, 10,600 tons of concrete and a refrigeration plant equivalent to 400 domestic refrigerators. The plant includes a large amount of stainless-steel equipment; for instance, there is an all-stainless-steel fermenting plant which controls the early stages in the growth of the organism while, at a later stage, there are a number of huge stainless-steel vessels in which the antibiotic is isolated from the fermentation liquors by chemical treatment (these vessels had to be fabricated on site) and a complete batch fractionating unit for the recovery of valuable solvents from the refining section of the process. A great deal of stainless steel is used in the sterile area, including the spore laboratory. All the stainless-steel plant was manufactured by Stainless Steel Vessels (London) Ltd.

Wholly British-built, the plant is operated entirely by British personnel. Pfizer Ltd. now employ 500 people altogether. Sufficient of the drug is being produced in the deep fermentation plant to supply all the requirements in the U.K. and sterling area, and it is estimated that an immediate saving of $5 million p.a. will be made in imports from the U.S.



Raw material storage tanks, more typical of a petroleum refinery than a pharmaceutical factory, at Sandwich.



Equipment for sterilising materials used in the spore laboratory. It is here that the mould *Streptomyces rimosus* is cultivated, and the whole process depends upon strictest control of conditions at this vital initial stage.

Deep fermentation process

The parent company, Chas. Pfizer, was the first to manufacture an antibiotic by deep fermentation. That antibiotic was penicillin, and today Pfizer are still the biggest manufacturers of penicillin in the world. With this experience behind them, they were able to bring a vast amount of know-how to the building of the Sandwich fermentation plant. Basically the process consists of three stages: fermentation of the mould *Streptomyces rimosus*, extraction of the active ingredients from the broth produced in the fermenters, and refining of the crude Terramycin ready for despatch to nearby Folkestone for pharmaceutical processing.

The master culture spores, contained in small ampoules, are kept in a freeze-dried state on sand or other suitable suspending medium. Processing starts when a microbiologist 'awakens' the spores by opening the ampoules while still within the sterile area. Still under sterile conditions, they are transferred to a small vessel where multip'ication begins and is continued until the weight of spores is

sufficient for transfer to the big stainless-steel fermentation tanks, which have a capacity of many thousands of gallons. While the mould is being multiplied the nutrient medium is being prepared for the fermenters. Medium preparation takes place in a special room. When ready the medium is pumped to the fermenters and sterilised with steam. Positive air pressure is maintained in the fermenters to prevent contamination from air-borne bacteria.

From the moment the tanks are seeded with the culture, heat and foam become two big problems. The heat of fermentation is kept down by circulating water around the tanks, while an anti-foam agent is periodically introduced throughout the entire process to counteract the other problem.

Recovery and refining

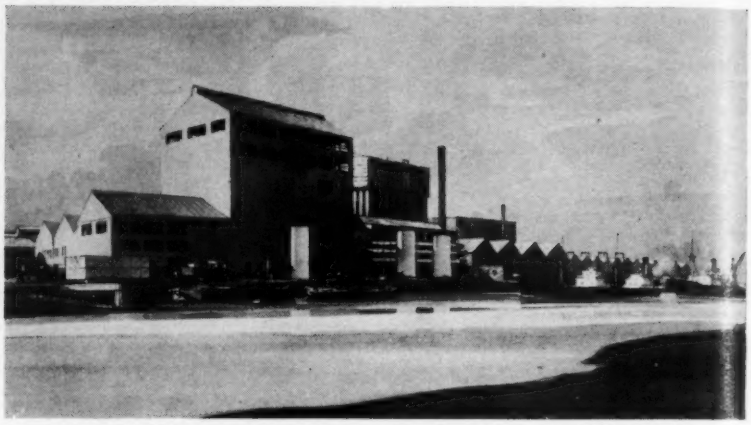
Several days after the original inoculation the fermentation is complete and the task begins of extracting the highly diluted active Terramycin from the thousands of gallons of broth. It is fed into stainless-steel holding tanks in the clarification area and treated with coagulants to make the mycelium (comprising waste mould and nutrient) more easily removable. The broth then passes through a stainless-steel rotary vacuum filter which removes the coagulated mycelium. The filtrate containing the active Terramycin is transferred to other equipment where it is chemically treated to yield an intermediate salt. This is dried and milled in preparation for further refining.

The powdered intermediate salt is dissolved in glass-lined vessels and all insoluble matter is filtered off. The antibiotic is crystallised out from the residue and the crystals are separated from the mother liquor by centrifuging. The crystals—comprising Terramycin hydrochloride — are washed, loaded on to trays, and dried in a vacuum oven. They are then recrystallised to ensure absolute purity. All solvents used in the process are recovered in a stainless-steel batch fractionating unit.

Pure Terramycin is a bright yellow powder and it is in this state that it is despatched to the Folkestone plant for incorporation into tablets, oral and nasal suspensions, intravenous and intramuscular injection fluids and other pharmaceutical preparations.

Suppliers of plant and equipment

Plant and equipment suppliers included the A.P.V. Co. Ltd. (*main contractor*); Cochran & Co. (Annan) Ltd. and John Marshall & Co. (Motherwell) Ltd. (*boilers*); Peter Brotherhood Ltd. (*cooling towers*); British Combustion Equipment Ltd. (*combustion equipment*); Broom & Wade Ltd. (*compressors*); Thomas Broadbent & Sons Ltd., Dorr-Oliver Co. Ltd., Edwards & Jones Ltd. and L. A. Mitchell Ltd. (*filtration equipment*); Enamelled Metal Products Ltd. (*glass-lined and special equipment*); Foxboro-Yoxall Ltd. (*instruments*); Baird & Tatlock (London) Ltd. (*laboratory equipment*); The English Electric Co. Ltd. and A. Reyrolle & Co. Ltd. (*main switchgear*); T. Guisti & Son Ltd. (*mild-steel equipment*); British LaBour Pump Co. Ltd., E.C.D. Ltd. and Worthington-Simpson Ltd. (*pumps*); J. & E. Hall Ltd. (*refrigeration plant*); Stainless Steel Vessels Ltd. (*stainless-steel equipment*); Allen West & Co. Ltd. (*starting gear*); Braithwaite & Co. Structural Ltd. (*tanks*); and The English Electric Co. Ltd. (*transformers*).



An artist's impression of the new Terramycin plant at Sandwich.

Canadian Research on Chemical Processes

The development of chemical processes that will utilise Canada's natural resources is an important function of the National Research Council of Canada in the Division of Applied Chemistry. From the Council's annual report it appears that, during the past year, petroleum products have received most attention. Studies have included work on the thermal and catalytic cracking of Canadian crude oils, the development of a method for bleaching lubricating oil using metallic sodium and continuation of the development of a commercial process for direct oxidation of ethylene to ethylene oxide. These investigations, all carried out on a pilot-plant scale, have had many ramifications. The work on ethylene oxide has led to basic studies on the phase behaviour and magnetic susceptibilities of potential oxidation catalysts, kinetics of the photochemical oxidation of hydrocarbons, the catalysed polymerisation of ethylene oxide, physical adsorption at gas-solid interfaces, and reaction rates at the various faces of single crystals of metals.

In addition, projects have been initiated dealing with the effects of high pressures on chemical reactions, and with extension of current knowledge of the thermodynamic properties of steam.

Continuous drying procedures that are applicable to heat-labile materials have been investigated. These methods utilise a newly developed technique for contacting solids and fluids and they show considerable promise for industrial use. This work has included thorough studies of heat and mass transfer.

In the Division of Applied Biology, studies of the production of citric acid by submerged fermentation of beet-sugar molasses have shown that the laboratory procedure developed here is feasible on a larger scale.

A new solvent system, acetone containing small amounts of water, was used in a pilot-plant column to fractionate vegetable oils. Results obtained at the Prairie Regional Laboratory, Saskatoon, Saskatchewan, indicate that a new solvent system, acetone containing small amounts of water, was used in a pilot-plant column to fractionate vegetable oils. Results indicate that separations on soya bean and linseed oils, equivalent to those obtained using furfural or liquid propane, can be achieved with lower capital investment and reduced operating costs.

Phosphate from the Bushveld

SOUTH AFRICA'S NEW PLANT EXPLOITS TRANSVAAL DEPOSITS

In this article, a South African correspondent describes the big new Foskor plant for producing phosphate rock at Phalaborwa and also discusses the prospects of exploiting the other mineral deposits in this area.

THE new plant recently brought into operation at Phalaborwa in the Transvaal by the Foskor undertaking (Fosfaatontginnings Korborafie (Edms.)- Beperk) is developing the only source of phosphates in South Africa of a quality suited for the manufacture of superphosphate and, under the present schedule, is producing about a fifth of the country's needs in rock phosphate. After this has been processed, it is delivered to the main fertiliser manufacturing firms in South Africa for the production of superphosphate.

There are other phosphate deposits in South Africa, but none of them are comparable to those at Phalaborwa, where the known reserves of phosphate ore are estimated at 500 million tons working to a depth of about 100 ft., with a phosphate content of 7% P_2O_5 (one-sixth apatite), yielding approximately 80 million tons of apatite or, at a consumption of 500,000 tons p.a., enough to last for 160 years.

The Foskor plant to deal with this phosphate has been built in the bushveld country near the Kruger National Park. The altitude is several thousand feet lower than that of the Witwatersrand and it is interesting to reflect the lion, the elephant and various other wild creatures still roam not far from this modern factory and the modern homes of the little village that has grown up around it.

Some 80 Europeans are at present employed to operate the plant and they are assisted by a staff of about 400 native labourers. In the production of the rock phosphate by modern methods a number of other minerals are yielded, and many more could be recovered if it was not decided to concentrate operations so far as possible on the production of the essential rock phosphate. Each day about 250 tons of –10-mesh magnetite are recovered by magnetic separation in the plant. The other minerals associated with the phosphate rock will certainly be recovered as time goes on. The zirconium oxide ore has a copper content of 0.6% Cu, and it is calculated that 2 tons could be obtained daily at the phosphate plant by simple gravity separation at some stage in the process now in operation. For a long time it would mainly consist of oxides. The copper extraction would be a greater problem than that of baddeleyite, but attention is to be given to its extraction and subsequent testing by means of a pilot plant.

The phosphate ore is recovered from the workings by ordinary quarrying methods and conveyed by lorry to the adjacent plant. Here the rock first undergoes the primary crushing before being passed on to the secondary crusher building, in which the rock is broken down to a suitable size for handling in the plant in which the phosphate is extracted. The broken rock is carried from point to point by means of long rubber conveyor belts. Banks of Wedag flotation cells have been specially designed for the flotation of the phosphate. The milling section is served by a rod and ball mill which works in conjunction with two duplex spiral classifiers. The crushed ore undergoes suitable treatment in the concentration plant, housed in one of the largest buildings in the factory. A large fine-ore bin has been built between the crushing section and the concentration building into which the material passes for appropriate treatment before being delivered to the superphosphate factories at Modderfontein, Umbogintwini and Somerset West.

The most modern machinery available for this purpose has been installed in the new factory, which in every regard has been able to benefit from world developments in the treatment of rock phosphate from the time it is mined to its eventual delivery to the fertiliser factories.

Background to the new undertaking

The Loolekop deposits in the Phalaborwa area have been known for many years, and in the past it was said that, because of the erratic distribution and certain economic factors, it would be difficult to exploit the deposits profitably. Since then keen prospecting, together with the prospect of using modern methods of treating the phosphate rock, encouraged the Government to exploit the deposits. They have formed a private company which is run on ordinary business lines, all the shares in this company being held by the Union Government.

Years ago a public company, known as South African Phosphates Ltd., erected in this region a plant for crushing and grinding the apatite-bearing rock and the concentration of the phosphatic material by means of a flotation process. Much the same process is being followed in the new Foskor plant, but on a much larger scale with better machinery.

In the previous undertaking, the raw phosphate rock thus obtained was passed through a 200-mesh sieve and the eventual product was placed on the local market under the trade mark of *Phosmeal*. It had a guaranteed phosphoric oxide content of 36%. The demand was not then large enough for the company to sell a sufficient quantity to make an attractive profit and, over 20 years ago, after producing some 5,000 tons of finely ground *Phosmeal*, the company went out of business. In the early days much of the apatite used for the production of raw ground phosphate was hand picked, the best of the available material being selected, but now it is necessary to dig down into the soil to work the deposits at lower level.

Geologists have described Phalaborwa as a pyroxenite mass covering an area of at least 7 sq. miles. In the pyroxenite is found a body of limestone, magnetite, apatite and serpentine, the apatite being the phosphate-bearing ore.

The ore body is a vertical or nearly vertical pipe of pyroxenite, and in this pipe lies the crystalline limestone, the younger carbonatite core which is about ½ sq. mile in extent. It lies more or less in the centre of the area and the small hill in which it rises out of the pyroxenite has long been known as Loolekop. This core has small amounts of apatite, serpentine and magnetite, but around it and at points forming part of Loolekop lies that wide band of apatite, magnetite and serpentine rock which provides the main Loolekop phosphate ore body.

This band has an area of about

⅛ sq. mile at the outcrop. Much remains to be learnt about it, as prospecting has been rather superficial in character. Many trenches have been dug at various promising points and some boreholes have been sunk to a depth of several hundred feet and, from the information so obtained, it seems that the phosphate values may extend down for a depth of 800 ft. and more, with in the main little decline in the standard of values. In this outcrop region, prospecting suggests that here may be recovered up to 70 million tons of average-grade 10½% P_2O_5 working down to 700 ft.

Future mining prospects in Phalaborwa area

However, around this promising outcrop, enclosed within its granitic-syenite boundary, lies the pyroxenite. This, together with the marginal shonkinite, covers an area of just under 6½ sq. miles and represents fully 90% of the known extent of the phosphate deposits that are to be worked now or in the future. The various by-products in the pyroxenite may help to finance the general development of the phosphates deposits, for it is believed that here lies what is probably the most valuable deposit of vermiculite in the world.

The phosphate in this area is of lower quality than that at Loolekop, the grade in general being only between 60 and 70% of that of the Loolekop phosphates.

On the other hand, it is more abundant and easier to mine on a large scale, and this to a degree offsets the disadvantage of grade. It has also proved under exhaustive tests to be eminently suitable for concentration. Thus, although the higher grade of the Loolekop phosphate is a decided attraction, it is considered that eventually the pyroxenite will be regarded as among the most important sources of phosphate in this part of the northern Transvaal. It is now anticipated that the total ore body it is planned to mine—the Loolekop together with the phosphates from the pyroxenite—will yield an ore with an average of 7 to 10% P_2O_5 and, after treatment, the recovered concentrates are expected to average from 33 to 34% P_2O_5, which is more or less of the grade of the rock phosphates imported by local fertiliser companies from Morocco and which will continue to be imported although the Foskor undertaking is now in production.

The factory now in operation in the Transvaal bushveld took about three years to complete, for, before the building materials and heavy plant could be taken to the site, modern roads had to be cut through the hilly country and the sometimes turbulent rivers of the region properly bridged. In every possible operation in the new plant electricity is used, as also in the surrounding village. Thus one of the first tasks in the erection of this £2½-million undertaking was the provision of a 2,500-kw. power station. Large quantities of South African steel were used in the construction of the various buildings and, where possible, South African machinery or components went into the mills.

British Patent Claims

The following are abstracts of some recent British patents which will be of interest to our readers. These abstracts are reproduced from the weekly Patents Abstracts Journal *by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.*

Treatment of cellulosic materials

Treatment of cellulosic fibres to inhibit fermentations is described, by incorporating into a slurry of the fibres a solution of mercurial composition containing a compound of the general formula: *Y*.Hg.*X*, where *Y* is an aryl group and *X* is an acetate, hydroxide, borate or a lactate group as solute, and containing acetic acid and lactic acid as a solvent.—736,387, *F. W. Berk & Co. Inc.* (*U.S.*).

Durene recovery

Pure durene is separated from a hydrocarbon fraction, boiling between 350 and 450°F., by chilling the fraction to a first temperature such that durene crystals form in a mother liquor, filtering the crystals, melting these filtered crystals, and then chilling them to form a second slurry of crystals at a temperature above the first temperature, and separating pure durene from the second mother liquor by centrifuging.—736,447, *Esso Research & Engineering Co.* (*formerly Standard Oil Development Co.*) (*U.S.*).

Concentration of isotopes

A complex compound *AB* of one compound *A* containing the isotope to be concentrated and another compound *B* is converted to a liquid, heated to form a vapour phase in which the ratio between the content of *A* in the form of the complex to the total content of the compound *A* is different from that in the liquid phase, and a countercurrent flow created between the phases in a cascade to effect an isotope exchange between them so that lighter isotopes are concentrated at one end of the cascade and heavy isotopes at the other end (*AB* may be, *e.g.*, BF_3, etherate for concentration of boron isotopes).—736,459, *K. E. Holmberg* (*Sweden*).

Chlorine treatment of vegetable fibres

In a method and apparatus for treating vegetable fibre pulp with gaseous chlorine or chlorine dioxide, the pulp descends by gravity through a first zone, in which it has a fibre content of 10 to 40%, and is there treated with gas for 10 to 45 min. The pulp, without washing, then passes by gravity to a second zone where it is diluted and agitated with water, so that the fibre content is below 10%, and it is again treated with chlorine or chlorine dioxide for up to 1 hr. in this zone.—736,491, *Cellulose Development Corporation Ltd., et al.*

Magnetic separator

A magnetic separator for separating magnetisable materials from liquid, dust, gas, etc., comprises a roller mounted on a shaft of magnetic material and energised by permanent magnets so as to have the same polarity throughout its surface, and a casing which surrounds and is spaced from the roller and is in magnetic contact with the shaft so as to form between the roller and the casing a substantially uniform magnetic field through which the material to be separated is passed. —736,332, *H. Spodig* (*Germany*).

Temperature control of rotors

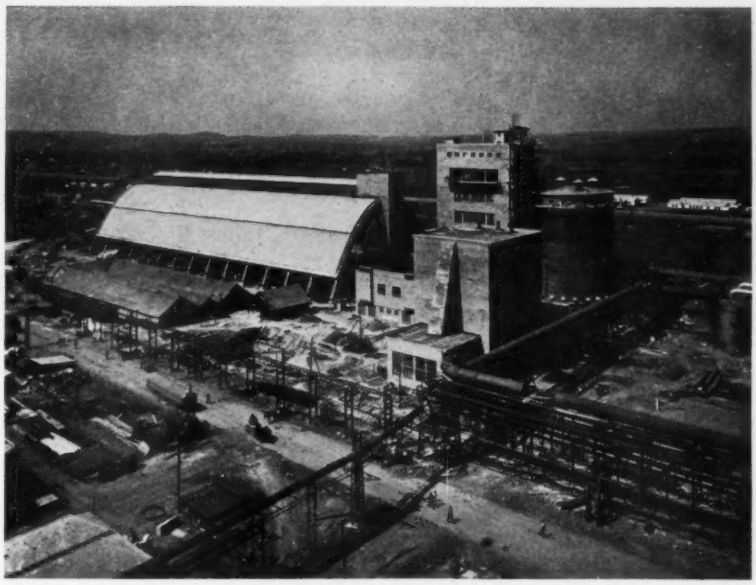
A (centrifuge) rotor, adapted to rotate at peripheral speeds of about 600 m./sec. and therefore subject to heating by gas friction, is maintained at a substantially constant temperature by using hydrogen at a reduced pressure to transfer heat from the rotor to a cooling jacket.—736,356, *Sandoz Ltd.* (*Switzerland*).

Furnace, etc., tube walls

Insulating or heat-resistant material is applied to a wall incorporating heat-exchanger tubes by positioning (*e.g.* expanded metal) reinforcing means in spaced relation to the wall and between such wall and shuttering, supplying the material in flowable form to the space between the wall and the shuttering, and vibrating the shuttering.—736,424, *Babcock & Wilcox Ltd.*

Hungary's Big New Chemical Works

Fertiliser production being stepped up



The huge fertiliser store seen in this photograph is a prominent feature of the new facilities being constructed at Borsod.

RAPID progress is being made in the construction of a fertiliser plant, claimed to be the largest chemical plant in Central Europe, at Kazincbarcika, County Borsod, Hungary. It is scheduled to begin production this year and will eventually turn out annually double the 1954 output of the whole of the existing nitrogenous fertiliser industry in Hungary. The plant will draw its power from the Borsod works at nearby Berente, two of whose 44,000-h.p. turbines are already in operation.

Building of the Borsod industrial complex began in 1950 and includes, besides the chemical works, the 200,000-kw. power station, the 1,900-ft.-long coal conveyor, a coal grader which classifies 10,000 tons/day and a coking works. The power station is fired by coal dust and the lump coal is coked for other industrial purposes. The coal itself is lignite from the Borsod region mines, brought in to the grader by a newly built telpher line.

According to the West German newspaper, *Frankfurter Allgemeine*, the chemical works will eventually cover an area of 16 sq. miles and be the largest and most up-to-date in Europe. An interesting feature is the huge fertiliser store, which is 75-ft. high and is built with 90-ton concrete arches set up in two sections.

An ammonia synthesis plant, which is equipped with a compressor powered by a 3,000-h.p., 6,000-v. electric motor, was first put under test last January. Tests began on a second compressor in July.

The Borsod plant is the No. 2 of Hungary's 'Big Three' chemical plants. No. 1 is the Pét plant reconstructed and enlarged after the war and powered at the end of 1953 by the Inota power works, at that time the largest thermal power plant in Hungary.

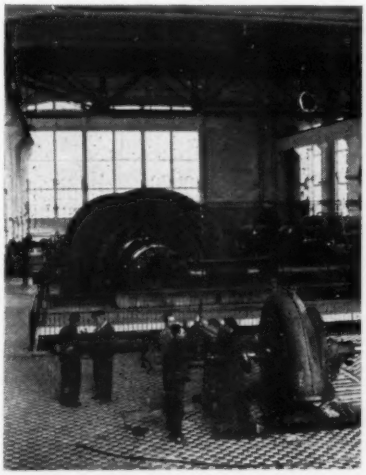
This year it was announced that Pét—140 miles south-west of Borsod—was being further enlarged and modernised at a cost of £3 million to achieve a 50% increase in output. It, too, produces nitrogenous fertiliser.

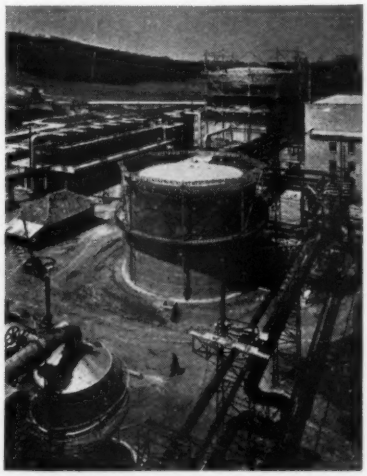
The building of the third big plant has only recently started at Tiszapalkonya, to the east of Borsod, on the banks of the Tisza River where it is joined by the Sajó. This plant will process natural gas to be piped from Rumania, 50 miles to the east, under a mutual assistance agreement between the two countries. It will be used for fertilisers and synthetics.

Tiszapalkonya's power station, which will be the biggest in Hungary, with 390-ft.-high chimneys, was begun this year. It will consume every day 6,000 tons of pulverised coal brought in by rail from the Borsod mines and later by a canal to be cut from the Sajó River. Handling of coal from start to finish will be mechanical.

So far, only preparatory ground work has been done on the chemical plant.

Water for cooling the power station's condensers will be pumped from the Tisza River at the rate of 1 million cu.m./day from a station sunk 40 ft. below the surface early this year. This depth ensures that the station is never starved of water even in time of drought. Target date for the first output from the power station is early 1957.





Left: **Assembling pumping equipment at Borsod, with the giant No. 1 compressor in background.** *Right:* **Part of the Borsod works, showing carbonisation plant on left.**

★ Personal Paragraphs ★

★ **Mr. W. B. Albright** has been appointed vice-chairman of Albright & Wilson Ltd. with special responsibility for the associated companies in the United States (Oldbury Electro-Chemical Co.), Canada (Electric Reduction Co. of Canada Ltd.) and Australia. **Mr. S. Barratt,** who is a director and the secretary of the company, succeeds Mr. Albright as managing director. The company state that this change has become necessary as a result of the expanding interests of the company both at home and abroad. **Mr. C. N. Wilson** has been appointed secretary of the company.

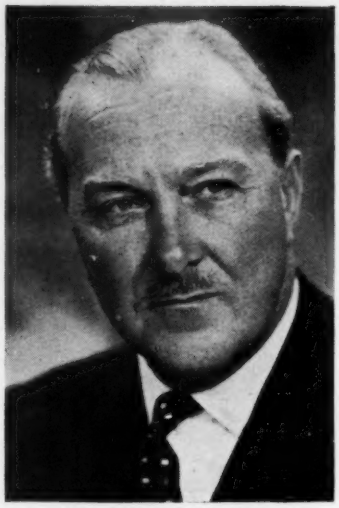
★ **Mr. Phillip A. Singleton** has resigned from the board of Monsanto Chemicals Ltd. in order to take up a new appointment with Monsanto Chemical Co., St. Louis, U.S.A. **Mr. D. R. Mackie,** commercial director, has been appointed acting managing director of Monsanto Chemicals Ltd.

★ **Mr. H. V. Potter** has retired as managing director of Bakelite Ltd. after being with the company and its predecessors for over 40 years. He is one of the pioneers in plastics and his biography is, in effect, a history of Bakelite Ltd. and also a major thread in the story of the British plastics industry as a whole. In 1948, when Bakelite was converted to a public company, Mr. Potter was appointed chairman and managing director. He was chairman of the British Plastics Federation in 1937-38 and is a past-president of the Plastics Institute. He was founder chairman of the Plastics and Polymer Group of the Society of Chemical Industry and was chairman again during the period 1948-50. He was chairman, also, of the Chemical Engineering Group during 1951-53. Mr. Potter is also a member of the Association of Chemical and Allied Employers and was chairman of the Association, and of the Joint Industrial Council, in 1952.

★ **Mr. G. W. Hodds** succeeds Mr. Potter as managing director of Bakelite Ltd.

★ The Ministry of Supply announce that **Mr. J. D. Parsons** has been appointed Director of Ordnance Factories (Explosives).

★ Honeywell-Brown Ltd. announce the appointment of **Mr. E. B. Foskett** to the management of their Glasgow office.



Mr. W. B. Albright.

★ **Mr. J. Addison** has been appointed general manager of Iranian Oil Participants Ltd., the shareholding company of the two operating companies set up in Iran under the terms of the 1954 oil agreement between the Iranian Government, the National Iranian Oil Co. and a group of international oil companies known as the Consortium. **Mr. H. E. Snow,** who had held the post since the formation of the company last year, has relinquished it and has been reappointed a managing director of the British Petroleum Co. Ltd.

★ **Mr. John Shirreff** has been appointed vice-president of Johnson Matthey & Mallory Ltd., the Canadian associate of Johnson, Matthey & Co. Ltd. He joined the parent company in 1927 and was employed in the platinum department at Hatton Garden until September 1939, when he left to take up war service. He resumed his duties in the platinum department in 1945 and, in 1949, he left to join the Canadian associate.

★ **Mr. S. C. Stewart** has been appointed general manager of the Industrial Alcohol Division of the Distillers Co. Ltd. A director of the division since its formation, he is also a division director of British Industrial Solvents and of the Carbon Dioxide Co.

★ **Dr. Otto Maass,** a principal research officer in the Division of Pure Chemistry of the National Research Council of Canada and formerly Macdonald Professor of Physical Chemistry and head of the department at McGill University, was recently elected an honorary member of the Chemists' Club of New York. Honorary membership is restricted to about a dozen top chemists throughout the world, and Dr. Maass is the only Canadian so honoured.

Mr. H. V. Potter (*right*), **who has retired as managing director of Bakelite Ltd., being presented with an illuminated album of signatures by Mr. C. C. Last, a director of the company.**

WHAT'S NEWS about

★Plant
★Equipment
★Materials
★Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in one of the attached postcards, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Highly resistant chemical pumps

A new range of centrifugal chemical pumps is claimed to have outstanding resistance to many acids, alkalis and slurries. The makers cite as an instance of their superiority the fact that they are capable of handling sulphuric acid with a high degree of resistance, *i.e.* a corrosion loss of up to 0.005 in. p.a. when made in *Worthite*—one of two alternative materials of construction.

The pumps are available in three different forms:

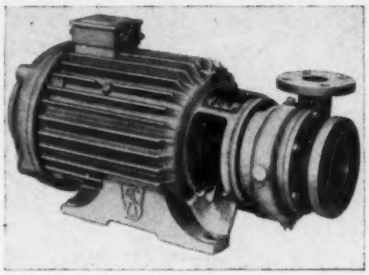
Type DFC, *Monobloc* construction. Pumps combined as one unit with totally enclosed, fan-cooled motors up to 1 b.h.p. in three-phase type, 1½ b.h.p. in single-phase, and 2 b.h.p. in d.c., wound for standard voltage ranges.

Type DMC, *Monobloc* construction. Pumps combined as one unit with totally enclosed, fan-cooled three-phase motors up to 17½ b.h.p. with windings specially impregnated with acid-resisting varnish. Stock motors are wound for 220 to 380, 400 to 440, 346 to 380 and 500 to 550 v., but other voltages can be supplied. Of this type, single-phase capacitor motors up to 6 b.h.p. in standard ranges between 220 and 550 v. are also available. The rotors are of the squirrel-cage type and virtually indestructible, the makers state.

Type DC. Pumps arranged for coupling to a special motor, engine or belt drive—supplied with bare shaft, flexible coupling or complete motor drive on a baseplate.

The material of construction for these pumps is *Worthite* corrosion-resisting alloy steel, or 18/8/3 stainless steel.

An important feature of these pumps is that the pump casing remains the same whatever the seal used, and stuffing box packing or mechanical seals can be interchanged simply by the use of adaptors to suit varying liquids. The mechanical seals can be supplied to suit either *Worthite* or 18/8/3 stainless-steel pumps, and are designed so that the stationary and rotating faces are kept together positively and any wear is taken up automatically.



Type DMC 'Monobloc' chemical pump.

The range covers a maximum output of up to 675 gal./min. with heads up to 125 ft., depending on capacity. The maximum total suction lift at full capacities—including all pipe and valve losses—is 15 ft. Up to 18-ft. suction lift can be obtained at lower capacities.

Some of the liquids which these pumps handle with very high resistance include acetic anhydride; acetic acid, glacial; acetone; alcohols; benzoic acid; boric acid, cold; butyric acid; calcium bisulphite; calcium hydroxide, 10% boiling; caustic potash, 70°F.; caustic soda, up to 50%; chlorosulphonic acid, 120°F. (pure); chloroform; copper sulphate; ethyl acetate, 70°F.; fatty acids; formaldehyde, 70°F.; glycerine; magnesium sulphate, 5%, 70°F.; nitric acid, all concentrations, 70°F.; oleum, up to 120°F.; phosphoric acid, 10%, 70°F.; phosphoric acid, 85%, 70°F.; refinery crudes; silver nitrate, 70°F.; sodium sulphate, 5%, 70°F.; sodium sulphide, 5%, 70°F.; sodium sulphite, 5%, 70°F.; sulphurous acid; and many others. **CPE 122**

Multi-cyclone dust collectors

The principle of the miniature cyclone unit is very old, but as a multi-cyclone unit it has not until very recently been an outstanding success for two reasons. The first has been the difficulty encountered in the design; the second, insufficient basic knowledge of the materials as applied to this particular type of separation. The combination of the two has meant inefficiency. To overcome these deficiencies and produce a practical solution to the problem, a British firm has engaged in a good deal of research and development, and the results of this work are two types of multi-cyclone collectors; the *Mancuna-Microclone* D4, in hiduminium or stainless steel; and the *Mancuna-Dustex* D52 and D450, in mild steel or stainless steel.

The *Microclone* is aerodynamically balanced to provide equal pressure to each cyclone tube. All the passages are polished and the gases are provided with a smooth, uninterrupted passage throughout the unit, manufactured in aluminium or stainless steel, precision engineered and designed for organic dust so that frequent cleaning can be carried out easily and efficiently. The precipitating sections and cover of the standard unit are made of cast aluminium alloy. The outlet tubes are standard in steel or aluminium. Special units can be made in stainless steel. The housing, inlet and hopper are of low-carbon steel.

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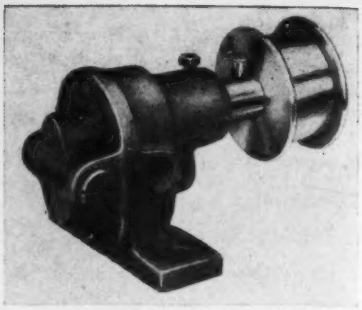
The element is the basic unit and consists of two halves (a left and a right). Each element contains 12 precipitating tubes. They are assembled in multiples of six tubes (half elements) and mounted at 45° in the housing. The housing has channel extensions that serve as a pivot for the arms that hinge open the cover; it allows complete accessibility to all passages for cleaning. The cover can be opened in a matter of minutes by removing a few 'T' handles.

Among the advantages claimed for this type of cyclone are:

(*a*) High efficiency.
(*b*) Fire hazard minimised by using aluminium castings.
(*c*) Accessibility to all parts because of the hinging cover and tube plate.
(*d*) Even velocity distribution, due to the planned design of the castings.
(*e*) Clean passages that permit distribution of the incoming dust-laden air without passing over the tubes themselves.

The *Mancuna-Dustex* D 450 and D52 collectors operate on a controlled helical-flow principle. It is stated that the inlet manifold feeds the individual tangential cyclone inlets at a constant pressure with no eddying. The construction is in heavy-gauge mild steel and a standard unit will operate at extremely high temperatures. For special conditions, stainless-steel units are available.

The manufacturers state that the individual inlet eliminates any possibility of plugging or build-up of fibrous or agglomerating materials. **CPE 123**



SALESCOPE SUDS PUMP

Recently introduced to the market is the suds pump illustrated. The gears are generated to give silence and maximum suds delivery from high-tensile steel. A novel feature is employed to obviate wear on the shaft by running the pulley on the gland bush. Relief valve is fitted to all models, thus avoiding damage to the drive or pump in the event of pipe blockage. The body is from close-grained cast iron, but these pumps can be made in P.B. bodies and stainless-steel gears. These pumps are often supplied without pulleys so that customers can fit their own and arrange direct motor drive. **CPE 124**

Heat recuperators

A firm of engineers in industrial fuel and heat economy is offering a number of heat recuperators, these being, in simple terms, a means whereby heat is transferred from the waste gas to the combustion air and/or fuel on its way to a furnace. A recent addition to the range of metallic recuperators is a composite tube recuperator, this being designed to preheat fuel gas to high temperatures without fear of leakage. It is stated that this is self-cleaning and involves no differential expansion or clogging troubles. No bolted or studded joints are used in its construction. It can be used with steel heating furnaces, soaking pits, blast furnaces, foundry cupolas, glass, chemical and non-ferrous furnaces, etc. Waste gas temperatures up to 1,050°C. can be used (or in excess of 1,500°C. if a first-stage radiation recuperator is used) with air preheats up to 750°C.

The tube is a casting made in the appropriate metal to suit the temperature conditions, and consists of a twin circular-bore plain internal heating surface surrounded by a finned external surface. The tubes are made in various lengths and have machined rectangular supporting flanges at the ends.

The entrance of the circular passages have spiral ribs cast integral with the tube body and the fitting of a loose stopper in the centre. It is stated that this arrangement enables a very high velocity of air or fuel gas to pass through the composite tube in a spiral motion, scouring the internal plain surface and giving a high rate of heat transfer. To the end flanges of the tube are cast special steel collars, which terminate in a rectangular shape, and these are welded together to form a perfectly tight joint. These steel end connections perform another important function—they are so shaped that they allow for the expansion and contraction of the cast heating tubes during operation.

Special flexible connections are also made between the tube and the connections, and the main framework, to prevent leakage on the external sides of the tubes.

For the forge, glass and smaller type of high-temperature furnaces, oil or gas fired, a new radiation unit recuperator is available. This is for waste gas temperatures up to 1,500°C., with air preheats up to 500°C. It is made in four standard sizes, for air quantities ranging from 4,100 to 27,000 cu.ft./hr. at N.T.P. They can easily be installed on the top of furnaces. **CPE 126**

EXPANSION JOINTS

A series of expansion joints or bellows and convoluted couplings for use in nuclear processes and in the petro-chemical and oil industries have been developed in America. These stainless-steel joints range in size from 28 ft. in diameter to those with a wall thickness of less than .005 in. They are made on machines designed and built by Solar Aircraft Co.

At Shell's Dominguez refinery, a 42-in. *Solar-Flex* expansion joint has been installed in a flue gas duct leading to the electrostatic precipitator. This unit works in an operating temperature of 575°F. and a pressure of 7 p.s.i., allowing 1 in. of offset movement and ¾ in. of axial movement. Special aeration fittings prevent solids from depositing in the bellows.

These joints are also used in aircraft jet engines. **CPE 125**

Drum mixer

A wide range of uses is envisaged for a revolving drum mixer now available, including mixing of powders in drums prior to emptying, re-mixing into solution pastes or pigments which tend to settle during storage, and cleaning of drums with the aid of suitable solvent.

The machine is designed to take a 40-gal. or 4-cwt. drum, but the non-driving set of rollers is adjustable to accommodate packages of smaller dimensions. The drive is from a direct-coupled helical reduction gear unit through a three-speed vee-belt drive designed to give varying speeds of rotation of the drum which is carried and rotated on rubber-tyred wheels. **CPE 127**

Bending tubes and forming conduits

The manufacturers of the *Staffa* hydraulic tube-bending machines have now extended the scope of one of their machines by providing, as accessories, forming dies to bend 2½-in. and 3-in. electrical conduits without undue distortion. These can be bent cold and unloaded without any preparation.

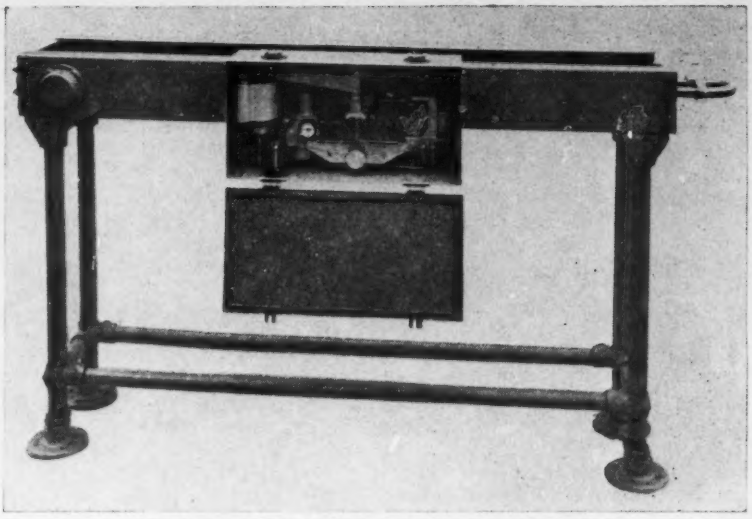
The machine is readily portable and needs no foundation bolts—it is eminently suitable for site bending. It is extremely light to operate and the open type of frame offers many facilities when bending to template or where close bends in two planes are encountered.

Among the advantages claimed for the machine is that unrestricted bending is permissible combined with maximum speed, as the two-stage action automatically ensures that the ram speed will adjust itself according to the load. Normally, with single-action pumps, the ram speed is constant whether bending ¾-in. or 3-in. pipe.

The unit is completely self-contained, developing a bending force of 8 tons and conveniently manipulated on the ground. The frame and general structure are extremely robust, so as to stand up to the many site conditions encountered.

The machine can be supplied with seven centre-forming dies for bending ¾-in., 1-in., 1¼-in., 1½-in., 2-in., 2½-in. and 3-in. electrical conduits, but with the aid of other attachments it is possible to bend various classes of tubes both ferrous and non-ferrous.

CPE 128



'Rotameter' density meter for liquids and slurries.

Continuous-weighing density meter for liquids and slurries

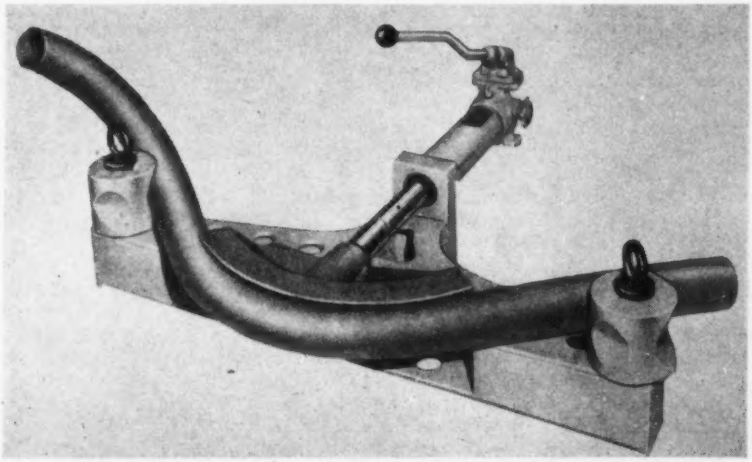
Originally designed for measuring the density of lime slurry, the 'R.M.' continuous-weighing density meter is now finding widespread application because of its several unique features. The meter consists essentially of a loop of pipe carrying the flowing fluid, which is flexibly connected to the main and weighed continuously on a pneumatic-force balance. It follows that any liquid or slurry that can be piped may also be metered, subject only to the limitations of the flexible connections. In the case of a slurry it is only necessary to maintain a velocity such that the deposition of solids is precluded and the meter readings will include the weight of solid particles too large to be detected by other types of instrument. Variations of velocity within wide limits have no effect on the meter.

Apart from the ability to handle slurries, the meter is characterised by the simplicity of its construction and calibration and by the fact that no air interface with the liquid is necessary.

The standard model has the tube loop mounted in a rigid stand suitable for industrial installation. Stainless-steel pipes, 1 in. o.d., are used (B.S. 1864) and connectors of silicone rubber. A compressed-air supply is needed for operation and the function of the instrument is to deliver a controlled air supply at a pressure proportional to the density of the fluid being metered. The output pressure range is 3 to 15 p.s.i. in accordance with British Standard practice, and is linearly related to fluid density. The span of density measured is 0.2 g./cc., with adjustment between 0.1 and 0.3 g./cc., and the meter can be used for liquids up to density 1.6 g./cc.

Supplied only as a transmitter, the instrument can be used with any indicating recording or controlling receiver of range 3 to 15 p.s.i.; the makers recommend and supply receivers and automatic control equipment if requested.

The density meter requires little maintenance. Removal of the tube



'Staffa' 3-in. open-type tube-bending machine and conduit formers.

bend permits cleaning of the tubes should any plant breakdown occur. The dashpot is filled with silicone fluid and needs no attention. The only regular attention necessary is to blow out the dripwell of the air-pressure regulator and filter unit.

A meter is now being produced with stainless-steel bellows connections so that a higher operating pressure is allowed. For chemical service, models are also projected with ebonite-lined pipes and butyl rubber connectors, and with glass pipes and PTFE connectors.

Most models can be supplied for liquids of density greater than 1.6 g./cc., or with span greater than 0.3 g./cc. to special order. **CPE 129**

'Meehanite' castings in the chemical and allied industries

Widespread use is being made of *Meehanite* metal castings, which are produced in a number of different types, each processed to give a different set of physical properties and to meet a particular need. They are broadly divided into four groups: general engineering, heat resistance, wear resistance and corrosion resistance. Each group consists of a number of types, all made to definite specifications. In this way, the engineer and designer can select the type best suited to meet his conditions.

In actual service it is often found that castings have to stand up to a combination of conditions. Heat combined with wear, or heat combined with corrosion, are often encountered and this calls for a type of *Meehanite* developed to suit the particular job. An example from the chemical industry is shown which represents a combination of heat and corrosion. The retort illustrated, previously made in steel, is used for sulphur distillation. It weighs 7½ tons and is subjected to a continuous working temperature of 750°C., as well as to the corrosive effect of sulphurous gases. The type of *Meehanite* developed for this difficult application has proved very successful.

The chemical industry provides many examples of *Meehanite* applications. These include stills, fusion pots, evaporating pans, retorts, etc. As with many industries, the foundry which produces these castings is frequently called in to study customers' problems in chemical applications. This collaboration makes for better casting performance. It provides a more exact knowledge of the service conditions. In many cases the foundry can suggest ways of improving the design of the casting and even of the operating conditions to get longer service life.

Many types of compressor units are made with *Meehanite* castings, and these units cover a wide field of service

Sulphur distillation retort in 'Meehanite' metal.

in the oil, chemical, mining and other industries. Pump castings provide another field of application for this metal, and there are *Meehanite* pumps for water works, irrigation, etc., where the requirements are mainly pressure tightness and machinability. A more severe condition is the pumping of abrasive materials such as water containing sand and gravel. This calls for a high degree of resistance to erosion and sometimes corrosion. An example is provided by a *Meehanite* pump which is used on the Congo for pumping mine water and is successfully meeting a combination of high pressure, corrosion and erosion.

In many industrial processes, castings are required to withstand the effect of heat. These heat applications fall into two main categories. One is where the heating is intermittent and the casting is subjected to sudden changes of temperature. Examples are ingot moulds, melting pots, retorts, slag pots, annealing boxes, etc. In this work, the sudden application of heat to the casting surface causes unequal expansion and severe local stresses, setting up small surface cracks. A special type of *Meehanite* has been developed to give resistance to thermal shock and has proved very successful for this type of work.

The other kind of heat application is where the casting is subjected to a constant high temperature. This needs an entirely different type of *Meehanite*, since thermal shock is absent and the problem is to prevent structural breakdown of the metal. Examples are furnace doors, frames and arches, heat-treatment pots, die casting pots, etc. The type of *Meehanite* used in these castings is giving excellent results because of its great resistance to the penetration of furnace gases and the protection given against breakdown of the metal structure. **CPE 131**

SEAMLESS FLEXIBLE METAL HOSE

A seamless, flexible metal hose, *Plessiflex*, has been developed which can withstand high temperatures and pressures over long periods. It has immediate uses in aircraft and fighting vehicles, and potential applications include service on engine steam lines, both static and marine, and numerous uses in the gas and chemical industries.

In appearance *Plessiflex* is a continuous, circular, metal coil formed in seamless metal tubing. Metals generally employed are stainless steel, brass and bronze. Experiments will shortly commence with the lightweight metal, titanium, which has an extremely high melting point and outstanding resistance to metal fatigue. **CPE 130**

Viscometer

An electrical viscometer which is stated to be robust and designed for continuous use in a plant, is also designed to be flameproof. According to the manufacturers, the *Poise-meter* can be arranged to indicate viscosity direct or can be arranged to give a signal to a potentiometer type of recorder/controller and thus give a permanent viscosity record and/or automatic viscosity control.

It is stated that the instrument is automatically compensated for variations in frequency, and automatic temperature compensation can be arranged. **CPE 132**

Collection and cleaning of dust- and fume-laden air and gases

A system which is claimed to represent a complete solution to many problems involving the collection and cleaning of dust-laden air and other gases, and which has been available in the United States for many years, has recently become available in Britain. A standard Holmes-Schneible *Multi-Wash* system consists of a collector, exhaust fan, ventilating hoods, duct work and piping to carry the collected material to the place of disposal.

Dust control in many different types of plant has been effected by a system based on these standard items, a typical example of which is a large *Multi-Wash* system comprising several collectors with fans, ventilating hoods, duct work and a common return effluent system, with central recirculating and settling tanks and recirculation pump. Whether the waste material is disposed of by rail, lorry or wheelbarrow, the Holmes-Schneible system can be adapted to suit specific requirements.

Water or other liquid can be employed using a suitable recirculating tank and pumps.

Whilst standard *Multi-Wash* units are made from mild-steel plate, special linings are used to meet particular requirements, or the entire unit is fabricated from materials such as stainless steel, copper, etc.

By using liquid at no head pressure, keeping all moving parts of the dirty gas stream and eliminating parts which rapidly wear, clog or burn, a highly efficient cleaning system has been evolved which, the makers state, is commensurate in capital and running costs with alternative, less effective equipment. The collector towers have no moving parts and may be located at a convenient point remote from the actual source of dust.

Quite apart from the removal of solid or liquid contaminants from gases, the Holmes-Schneible towers find many other applications.

The standard *Multi-Wash* collector, type 'HC,' is used where the highest possible efficiency of dust extraction is necessary and where a large percentage of the dust falls in the sub-micron size range. It consists of a cylindrical tower fabricated of any type of metal sheet, plate or coated steel, depending upon the nature of the dust and fumes to be collected and the liquid to be used as the washing medium.

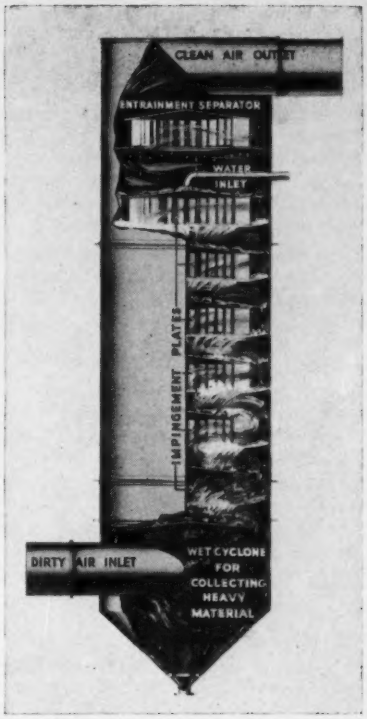
Contained within the tower are 6½ impingement stages, each comprising a horizontal disc from which curved vanes or baffles are suspended. Each impingement stage rests upon a shelf. An entrainment separator, similar in construction to the vaned impingement stage, is placed above the foregoing units, forming a seventh tier. The tower terminates in a cone at the bottom.

Dust, odour or fume-laden air enters the collector tangentially through a duct or ducts (see illustration) just above the cone and below the lowest, or vaneless, impingement plate. The spiral motion thus induced is maintained by the curved vanes encountered by the rising air at each impingement stage. The cone-shaped bottom serves as a wet cyclone, collecting the heavier particles as soon as they enter the tower.

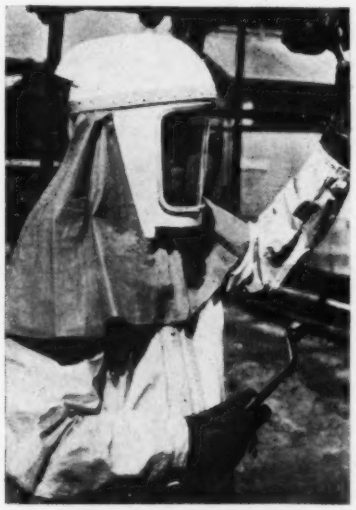
The washing agent, usually water, is introduced at no head pressure above the centre of the top impingement plate, gravity causing the water to flow downward against the upward flow of the rapidly rotating air current. The rotary motion of the ascending air sets up a similar motion in the descending water, causing it to be cascaded evenly over the discs, vanes, shelves and side walls of the collector. This violent whirling agitation forces the liquid off the edges of each of the discs and shelves in a finely divided heavy water curtain, through which the air must pass. This combination of water curtain, spray and impingement action envelopes the particles of dust rising with the air and carries them down into the cone and out of the collector.

Clean air, having been thoroughly washed by the turbulent scrubbing action imparted in passing under and over the six sets of shelves and discs and between the vanes of the impingement plates, passes through the entrainment separator located at the top of the tower above the water inlet. Here the air is freed of any excess moisture which drips down into the top impingement plate where it merges with the incoming liquid. The air leaves the collector devoid of dust, odour, fumes and excess moisture.

The makers point out that the removal of the dust and fumes as a wet sludge avoids the secondary dust nuisance often attendant upon the disposal of dry dust from certain types of collectors. **CPE 134**



This photograph shows the principle of the standard Holmes-Schneible 'Multi-Wash' collector, type HC. These collectors are made in 1,000- to 40,000-cu.ft./min. capacities and multiple units.

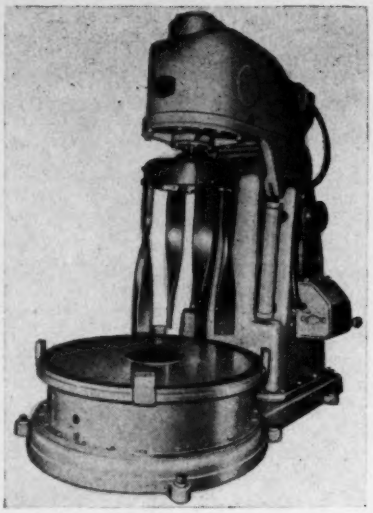


PROTECTIVE HELMET

The R.F.D. Updraft helmet, made with Geon PVC, which protects maintenance workers from flying particles, acid and other corrosive sprays. The helmet itself—both outer shell and face shield—are in rigid Geon PVC, which is described as chemically resistant, non-flammable and highly resilient, while the acid-proof cape is made of PVC-coated fabric.. **CPE 133**

HEAVY-DUTY MIXER

This heavy-duty Chemix *mixer is specially designed for dealing with arduous mixing jobs and, according to the makers, is specially suitable for the intimate mixing of heavy pastes and solid materials. It is completely self-contained and is supplied in* 50- *or* 150-*gal. capacity. The mixing pans and mixing blades can be made in stainless steel, mild steel, copper, etc., and are removable to facilitate transport or they can be hydraulically tipped to empty. During mixing they rotate on the turntable, which is mounted on a large thrust race and spiral roller bearing, and the mixing paddles are of a very heavy design and revolve on a different axis from the turntable, so that an epicyclic mixing action is obtained and the entire contents of the vessel are repeatedly turned over. The mixing head is tilted clear of the mixing pan by hydraulic power operated by hydraulic pump and motor housed in the machine head. Dust covers can be provided for the mixing pans, and all controls are conveniently grouped.* **CPE 135**



Synthetic calcium silicates

A new line of synthetic calcium silicates called *Micro-Cel* has been announced by an American company. Produced by the chemical combination of lime and diatomaceous silica, *Micro-Cel* is a powder available in specific grades which offer the following wide range of physical properties:

Colour	White or off-white
Absorption, % by weight:	
Water	300 to 600
Oil	275 „ 500
Bulk density, lb./cu.ft.	5 „ 15
Ultimate particle size, micron	.02 „ .07
*p*H	8 „ 10
Moisture (free), wt., %	5 „ 8
Refractive index ..	1.52 „ 1.55
Available surface area, sq.m./g.	95 „ 175

According to the makers, these synthetic calcium silicates provide a combination of properties which may hold the key to lower costs and improved products in many process formulations. The makers list some of the effects which may be expected as follows:

Absorption of liquids. The material will absorb 1 to 2½ times its weight of liquids and still remain a free-flowing powder.

Uniform dry dispersion. Different *Micro-Cel* grades with particle sizes as low as .02 microns and particles of rounded to spherical shapes, proside fast, uniform blending without vegregation.

Viscosity control. Various degrees of viscosity up to a paste or semi-solid can be achieved by adding relatively small quantities of *Micro-Cel*.

Anti-caking agent. The material's high absorption and fine particle size of less than 0.1 micron effectively controls caking of deliquescent products and ensures flowability even after prolonged storage.

Bulking agent. A small percentage of *Micro-Cel* materially increases the bulk of dry powders and allows control of package density.

Other suggested uses are as a pigment, suspension agent, flatting agent and for reinforcing pigment.

These and other advantages have not all been fully explored to date. However, it is stated that *Micro-Cel* has been proven as an absorbent-grinding aid for high liquid concentrate insecticide wettable powders, as an anti-caking agent in fertilisers, insecticide dusts, cleansers and detergents.

Among the high-concentrate wettable powders which have proven commercially practical are 70% *Toxaphene*, 15% *Aramite*, 75% DDT, 50% *Heptachlor* and 75% *Dieldrin*. Examples of dry dust concentrates which have been proved practical for commercial production are 70% *Toxaphene*, 50% *Aramite* and 50% *Heptachlor*.

Micro-Cel is now being produced on a pilot-plant basis. Full-scale production is anticipated during the first part of 1956. **CPE 136**

Abrasion- and corrosion-resistant linings

A variety of applications for *Linatex* linings have been recorded, these being resistant to a wide range of acids and alkalis at temperatures up to 65°C. In chemical pipe work, pipe linings are bonded into the bore of the pipe and carried out over the flange face. No jointing gaskets are required. Fans, cyclone units, hoods and many similar pieces of ancillary equipment used in chemical works may be *Linatex* lined for protection. It is stated that these linings are also suitable for all plating processes except chromium. The many pickling and metal protection liquors employing phosphoric or sulphuric and hydrochloric acids can be safely handled with this material, it is stated.

Linatex is a 95%-pure natural rubber produced from fresh latex in Malaya by a patented process which, it is claimed, results in a material which is not only unaffected by many chemicals but also possesses remarkable resistance to abrasive wear, coupled with great tear resistance and resilience.

The linings can be applied to metal, wood or concrete. When applied in materials handling plant, they are designed to meet specific operating conditions, a suitable thickness being employed, having regard to the quantity, size and nature of the material being handled. In addition to cementing, various methods of fixing are used to work in with existing structural features of the plant.

The linings find a particularly wide use in mining plants, and one instance is cited of a launder carrying 150 tons of ore per 24 hr. where ¼-in. steel was worn out in 264 hr., whereas ⅜-in. *Linatex* was unworn after 4,180 hr. In another application, it is stated that, whereas steel idlers lasted only six weeks, *Linatex*-covered idlers lasted three years. **CPE 137**

Acid pump

A direct-action dual-stroke hand pump delivering ⅓ litre per stroke is constructed from rigid PVC and is stated to be suitable for most concentrated acids and alkalis. According to the manufacturers, this pump will empty a 10-gal. carboy in 4 min., while no priming is necessary. All parts are claimed to be interchangeable and easily repaired. **CPE 138**

Cold filtration of oils

A number of oil filters have been designed for the cold filtration of transformer and carbonised switch oils. Among these units are the T5, which is a portable unit, and the T10, which is available as a portable, mobile or static unit.

There are four main components:

(1) *Pump*. A *Mono* pump in cast iron is fitted with a relief valve set to open at 100 p.s.i., and a hand-operated by-pass is provided so that the output of the pump can be varied at will.

(2) *Water eliminator*. This is connected on the suction side of the pump and is filled with a number of thin sloping plates packed parallel to each other in a vertical pile. The oil being drawn through the separator is made to flow between the plates at a very slow rate.

(3) *Mixing chamber*. This is formed by the lower half of the filter casing. It is provided to enable the *Metasil* (filtering powder) to be mixed with the oil for forming the bed on the surface of the packs.

(4) *Filter*. The steel filter container is designed for working pressures up to 100 p.s.i. The top cover and division plate are bolted to the top of the cylindrical container and brass packs are screwed by their pack adaptors into the division plate which separates the clean from the dirty side of the filter.

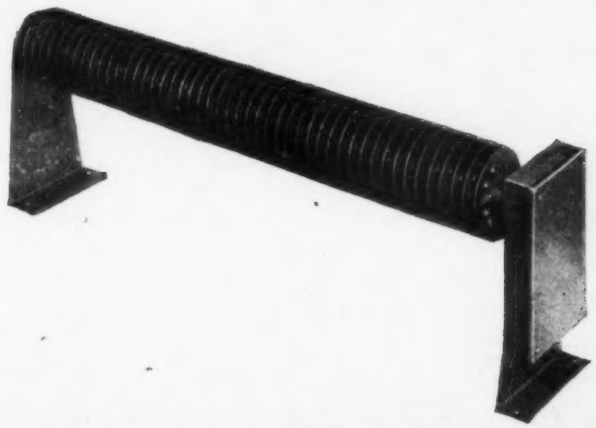
With a *Metafilter*, oil is filtered at atmospheric temperature; therefore no heat is required and there is consequently low power consumption. Because of this cold filtration, the makers state, there is no question of moisture or solid impurities being in solution when the oil has been filtered.

All traces of moisture in suspension and solution, as well as solid impurities (including microscopic fibre and colloidally dispersed carbon) are completely removed during one passage through the filter. There is no aeration during the process and the filter can be connected to high-tension transformers on load, since the system is entirely enclosed. The degree of filtration does not vary with the rate of flow. **CPE 139**

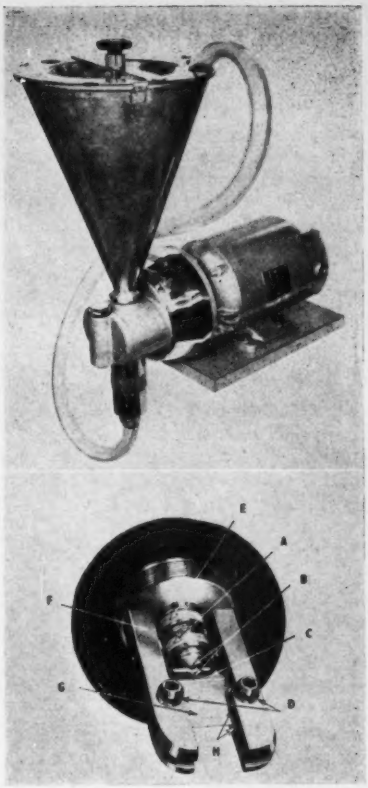
Finned-tube heater

A finned-tube heater which combines a high rating with a large surface area has been developed and is stated to be particularly suitable for industrial ovens and drying rooms where temperatures of 200 to 350°F. are required. In natural convection ovens working between such temperatures the heater has an operating surface temperature of about 500°F.

The heater comprises a mild-steel tube with a crimped gill, of 4-in. outside diameter. This tube houses a withdrawable element consisting of a spiral, operating at low temperature, carried on insulators which are assembled on a metal runner. The tube is of heavy-gauge steel and weighs about 7 lb./ft. run. A mild-steel connecting box is provided at one end of the heater with a bracket for conduit entry at the base. Automatic temperature controls for controlling room or oven temperature can be supplied as required. **CPE 140**



G.E.C. finned-tube heater for providing relatively high ambient temperatures with a low heater surface temperature.



New ultrasonic emulsifier (*top*) and vibrating element (*bottom*) showing: (*A*) jet; (*B*) distance between jet face and blade edge, 3 to 5 mm.; (*C*) ground edge of blade; (*D*) blade retaining screws; (*E*) jet locking collar; (*F*) blade arms; (*G*) vibrating blade; (*H*) blade packing pieces.

Ultrasonic emulsifier

Small-scale ultrasonic emulsification is practicable with the *Minisonic* self-contained homogeniser. The machine has been designed for laboratory and small-batch production on the same principles as the *Rapisonic* method of emulsification and homogenisation by ultrasonic cavitation. A similar vibrating element is used in the new machine so that a product can be transferred from the laboratory stage straight into full-scale production without altering the manufacturing technique.

The machine is a self-contained unit. No pre-mix vessels or ancillary plant are required. Emulsions can be prepared to any given formula in batches of up to 1 gal. The continuous phase in the primary funnel can be recirculated *via* the vibrating element using a flexible hose, and the disperse phase can be introduced through the inner funnel at regulated speed. The finished product can be discharged, again using the flexible hose. **CPE 141**

Tube cleaners

Air-operated tube cleaners are being marketed which have been specially designed to suit the arduous conditions usually encountered in oil refinery operations. These units can be supplied for dealing with tubes from ½ in. to 16 in. internal bore, and special equipments are also available for the cleaning of catalytic reactor tubes.

Various types of cutter heads deal with most descaling problems, and the selection of any particular head will be governed by the scale conditions met.

The heads are made from steel having a tough core with a deep, hard base. The cutters are made from a refined alloy cast steel, hardened and tempered to stand up under severe service. **CPE 142**

Paints that resist chemicals

The *Metavin* system of chemical-resistant plastic paints is claimed to have a number of advantages which make them attractive to those industries where corrosive fumes are developed or where corrosive chemicals are used. The essential difference between the *Metavin* system and other paints is that the former are based on relatively inert plastics rather than natural oils or resins. The plastics in this case are polymerised vinyl chlorides and acetates, which are inert to acids, alkalis, alcohol, grease and oils. Moreover, they are tasteless, odourless and non-toxic.

The plastics are, however, soluble in certain organic solvents such as ketones, chlorinated hydrocarbons, etc., and it is therefore possible to compound them with pigments to produce paint. As they are completely polymerised, the film is formed by evaporation of the solvent only, which avoids the tendency for the film to shrink and grow brittle with oxidation. Orthodox paints shrink and age until they become useless as protective agents.

As the plastics are water-white in colour, it is possible to make paints of any colour from them, including pure white. White and black are now available in a glossy form, but other colours can only, at present, be produced in a semi-gloss.

The *Metavin* system is applied as four distinct operations: (1) preparation of surfaces; (2) initial coat application; (3) intermediate coat application; and (4) finishing coat application. The initial coat stage is variable depending on whether the surface is free of previous paint, and the intermediate coat is variable depending on whether the finish has to be completely non-toxic. Application of the paints may be by brush or spray; the coverage of all grades is at a minimum of 250 sq.ft./gal. All grades dry within 6 hr., but for better results can be left overnight to set hard. **CPE 144**

BULK TRANSPORTER FOR POWDERED CHEMICALS

A new-type 20-ft. container built for Imperial Chemical Industries Ltd. for the bulk transportation of polythene resin. Mounted on a Foden F.G. 6/15 eight-wheel chassis, the vehicle will carry 12 tons of material—an extra large payload which has been achieved by the use of Homalloy *alloy, which is three times lighter than steel, throughout the entire construction.*

The container is 'double-skinned' to facilitate both internal and external cleaning, whilst the space between the walls can be used for the introduction of insulating material, if and when required.

Loading and discharge openings (45°) *are positioned at the top front and bottom rear respectively, and rapid discharge is effected by the positioning of baffle plates at the inside rear of the container, which guide the material through the discharge opening.*

The outside length of the vehicle is 26 ft. 6 in., extending to 31 ft. 10 in. in the tipped position. **CPE 143**

Non-staining antioxidant for rubber

A new non-staining antioxidant, *Nonox WSP*, is claimed to be of outstanding potency and equal in antioxidant power to phenyl-beta-naphthylamine (one of the most powerful of the established staining antioxidants). At the same time, it is claimed, it affords notable protection against the ageing brought about by contamination of the rubber with copper and/or manganese. No blooming has been observed when using *Nonox WSP* in the recommended proportions.

The manufacturers say that, on the score of freedom from staining, the antioxidant gives excellent performance. Exposure to sunlight can, in certain circumstances, give rise to a light pink discoloration, but this disappears later, to be replaced by a very light-cream discoloration.

It is further stated that exposure tests carried out in Great Britain and in northern India have shown that *Nonox WSP* delays the onset of crazing and retards its development over long periods of exposure. Although it gives some measure of protection against flexcracking in both black and non-black loaded stocks, it does not, however, equal the established anti-flexcracking antioxidants in this respect.

The manufacturers expect that *Nonox WSP* will find extensive use as an antioxidant and copper inhibitor for compounds of high quality, including latex articles. **CPE 145**

'STYRON' POLYSTYRENE

Following the advent of *Styron* polystyrene in its toughened form as *Styron* 475, this material will now enter the industrial field in Britain in a big way. Prominent applications are in the refrigerator industry and in radio and television sets, while another very important industrial outlet lies in electric battery manufacture.

As a lightweight thermoplastic material, *Styron* has several specialised applications in the chemical industry. It has good resistance to alkalis, salts, dilute mineral acids, lower alcohols and water, but is soluble in aromatic and chlorinated hydrocarbons, esters, ethers and some terpenes.

Piping extruded from *Styron* 475 and tank linings, injection-moulded in this polystyrene or formed from the sheet material, are suitable for handling a wide range of chemicals. Another interesting application of *Styron* is in the manufacture of protective covers for instruments in chemical works.

The general-purpose grade, *Styron* 666, is suitable for a wide variety of applications where its crystal clarity or its brilliant colour can be used to full advantage.

CPE 146

World News

Albright & Wilson and Marchon Products Link-up

Albright & Wilson Ltd. have announced arrangements for the purchase of Marchon Products Ltd., Whitehaven, Cumberland, through the acquisition of the ordinary and preference share capital of Marchon Products, which also controls the ordinary share capital of Solway Chemicals Ltd.

There is no intention of changing the present administration or direction of Marchon Products or Solway Chemicals. Mr. F. Schon will continue to act as chairman of those companies. An invitation will be extended to him to join the Albright & Wilson board as soon as certain formalities have been completed, and a nominee of Albright & Wilson will be appointed to the board of Marchon Products and Solway Chemicals.

In making this announcement, Albright & Wilson pay tribute to the business built up over the past 15 years by Mr. Schon and his colleagues. Detergent intermediates, sulphonates, higher fatty alcohols and sodium tripolyphosphate are among the main products manufactured by Marchon Products, while Solway Chemicals are now operating their plant for the production of sulphuric acid and cement from anhydrite, which is mined on the company's property.

In November, Albright & Wilson issued to its shareholders a notice of an extraordinary meeting for the purpose of considering and, if thought fit, passing a resolution that the capital of the company be increased to £9 million by the creation of 6,084,852 ordinary shares of 5s. each and 1,978,787 unclassified shares of £1 each.

Marchon's rapid expansion

A statement from Marchon Products Ltd. and Solway Chemicals Ltd., points out that for some time it had been apparent that, due to Marchon's rapid expansion, its ordinary share capital had become completely out of gear in relation to the total capital employed in the business. In the past, it had been the practice to finance the expansion in Marchon mainly by ploughing back all profits, but the necessity arose to find additional capital in the form of loans, particularly for the consideration of the Solway sulphuric acid and cement plant.

The large production capacity of sulphuric acid now existing in Whitehaven provides the basis for further development of Marchon's activities, particularly in regard to the manufacture of phosphates, for which there is a constantly rising demand. But the capital needed for such further expansion could not be raised without enlarging the financial basis of Marchon-Solway. To attempt this by the issue of additional ordinary share capital presented difficulties for various reasons. In consequence, the method was adopted by incorporating Marchon-Solway into an existing organisation which had the facilities lacking in Marchon.

Both companies are engaged in the manufacture of phosphoric acid and its derivatives, but are operating entirely different processes. The considerable interests which both companies have in other fields do not overlap in any way. Therefore, the statement points out, the link up can be regarded as a means of strengthening both organisations, and it is confidently assumed that by the pooling of such resources as research and engineering, etc., a considerable increase in the efficiency of operating combined units will result.

New £11-million fertiliser project

As a result of a long-term agreement being signed between Shell Chemical Co. Ltd. and Fisons Ltd., work will shortly begin on the construction of two new plants in the Thames estuary for the manufacture of fertilisers. It is estimated that this dual project will cost altogether £11 million.

The first of these plants, costing £6½ million, to be built at Shell Haven in Essex, will convert refinery gases (or other petroleum hydrocarbons) into ammonia and nitric acid. This initial stage of a longer-term project will be completed by 1958 with a capacity of 75,000 tons p.a. of ammonia. Subject to the necessary land being available, the complementary plant will be built by Fisons nearby at a cost of £4½ million. It will use 60,000 tons of ammonia from Shell Haven for the production of ammonia-based fertilisers.

The balance of the ammonia output at Shell Haven will be used by Shell for the manufacture of ammonium nitrate/limestone fertilisers for the U.K. market. In addition, anhydrous ammonia and nitric acid will be made available to industry.

In carrying out this programme, Shell will draw upon experience acquired in the U.S. and in Holland, where it already manufactures ammonia on a large scale.

Ammonia synthesis gas plant

The Power-Gas Corporation Ltd. have been appointed by Imperial Chemical Industries Ltd. Billingham Division, to act as main contractors in

Chemical Plant Industry's Progress

A record number of over 400 members and their guests attended the annual dinner of the British Chemical Plant Manufacturers Association in London last month. In his speech the chairman, Mr. W. J. Hooton, referred to the encouraging growth in membership which, 20 years ago, was only 45 and today was 220.

Mr. Hooton outlined the Association's policy on chemical engineering research and said that they were in full agreement with the Association of British Chemical Manufacturers on the decision not, at this stage, to set up a research association of the normal D.S.I.R. type. Instead they agreed that fuller dissemination of existing information was desirable. The B.C.P.M.A. propose to maintain close liaison with the chemical manufacturers by representation on the A.B.C.M. research committee; secondly, the Association's own research committee was to be enlarged and it was hoped that the A.B.C.M. would have a representative on this committee; thirdly, the Association proposes to set up an information exchange service.

The Association's chief guest was Mr. D. Walker-Smith, newly appointed Parliamentary Secretary to the Board of Trade. Discussing the economic importance of the engineering industry, he said that fixed investments in 1954 totalled £2,452 million, of which engineering goods made up about half. Within that half, plant and equipment accounted for one-third of the total, *i.e.* £853 million. In addition, engineering goods accounted for not less than two-fifths of total exports and had an important contribution to make in the future. The chemical plant industry played an important part in the export effort of the chemical industry which was now running at the rate of £220 million p.a. The chemical plant industry was also a direct exporter and in the gas and chemical machinery sector alone was exporting at the rate of £2,600,000 p.a.

connection with a substantial extension of their ammonia synthesis gas plant.

The plant, which will be built to the overall technical direction of I.C.I., who are themselves designing the oil gasification units, is a new departure in the U.K. Oil will be gasified with oxygen under pressure and the equipment to be provided will also include oxygen plant, carbon monoxide conversion plant, gas purification plant and compressors.

As part of the purification train, Power-Gas are designing and supplying a plant for the removal of carbon dioxide and hydrogen sulphide by means of hot potassium carbonate solution.

Plastics exports record expected

A new record is expected to be set up for 1955 in the export of British plastics raw materials. Figures for the first nine months of the year—62,000 tons, worth nearly £16,800,000—are above those for the corresponding months in 1954 (50,000 tons valued at over £15 million). If the rate of exports is maintained, last year's record value of over £20 million will be exceeded by about £2 million.

Best markets for the exports have been Australia (over £2.4 million); South Africa, India, Holland, Sweden and New Zealand (all between £900,000 and £1 million); Denmark (over £700,000); and Norway (over £600,000).

The raw materials exported include synthetic resins, moulding powders, sheet, rod, tube, film and foil, but not finished products or plastics materials incorporated in other finished products, such as motor-cars and radio sets.

Production of new carbon blacks planned

Plans to produce HAF and other new grades of furnace black in the United Kingdom have been announced by United Carbon Co., of Charleston, West Virginia, U.S. The additional plant to produce *Kosmos* 60 and *Dixie* 60 (United's HAF blacks) will be installed at the Swansea works of United Carbon Black Ltd., which has for some time been producing black under licence from United Carbon Co. and marketing it as *Dixie* 45 and *Kosmos* 45 through Anchor Chemical Co. Ltd. and Chance & Hunt (a section of Imperial Chemical Industries, Ltd.). Production of the HAF blacks is expected to begin in the spring of 1956. The new plant will also produce ISAF and FEF grades.

Another recent development by United Carbon Co. has been the acquisition of the former U.S. Government synthetic rubber plant at Baytown, Texas. The production from this plant, consisting of GR-S/carbon black rubber master-batch and oil-extended GR-S/carbon black master-batch, will be offered to the trade under the trade name *Baytown* by Chance & Hunt and Anchor Chemical Co. Ltd.

United Carbon are organising and extending their research and technical service facilities in the U.S. to obtain full advantage of correlated work on both carbon black and synthetic rubber.

Industrial trust to help science teaching in schools

A number of companies concerned in the chemical, electrical and mechanical engineering fields of industry, viewing with growing disquiet the shortage of scientists, mathematicians and technologists, have decided to take steps to assist the teaching of pure and applied science and mathematics in secondary schools.

The sponsoring companies are: Associated Electrical Industries Ltd.; British Insulated Callenders Cables Co. Ltd.; British Petroleum Co. Ltd.; British Portland Cement Manufacturers Ltd. Group; Courtaulds Ltd.; The Distillers Co. Ltd.; English Electric Co. Ltd.; Esso Petroleum Co. Ltd.; General Electric Co. Ltd.; Arthur Guinness, Son & Co. Ltd.; Imperial Chemical Industries Ltd.; Imperial Tobacco (Great Britain & Ireland) Co. Ltd.; Rolls-Royce Ltd.; the Shell Petroleum Co. Ltd.; Tube Investments Ltd.; Vickers Ltd.; and the Wellcome Foundation Ltd.

These companies have established an industrial trust to be known as the Industrial Fund for the Advancement of Scientific Education to Schools. The assistance will be given solely by the provision of capital grants towards the building, expansion, modernising and equipping of science buildings in independent schools and direct-grant schools in the United Kingdom, the Channel Islands and the Isle of Man. Over £1½ million has already been guaranteed, but it is believed that many other companies that depend on adequate supplies of pure and applied scientists and technologists will wish to add their support in their own as well as in the national interest.

The address of the fund is 20 Savile Row, London, W.1.

New factory for Foxboro-Yoxall

Foxboro-Yoxall Ltd. have acquired a 55-acre site at Redhill, Surrey, where work will shortly start on the erection of a new factory.

B.P.'s £6½-million gasoline project

Plant for the production of some 130,000 tons p.a. of aviation gasoline is to be installed at the British Petroleum Co.'s Kent oil refinery on the Isle of Grain. The cost is estimated at £6½ million.

The company reports that, in addition to the growing demand for fuels for turbine-engined aircraft, the company's outlets for aviation gasoline of the highest octane rating are still expanding. Some supplies are expected from Abadan now that one of the alkylation units there has resumed production, but B.P. considers that a new aviation gasoline plant is necessary west of Suez to meet this increasing demand.

The new Isle of Grain plant is expected to be in operation in 1958 and will effect a considerable saving in dollar expenditure on imports of aviation gasoline from the U.S.

Heat exchangers in Italy

Head Wrightson Processes Ltd. have signed an agreement with D. Bonaldi & Co. for the manufacture in Italy of the Head Wrightson air-cooled heat exchangers.

Ion-exchange lectures

A course of five lectures on ion exchange and its applications is to be held at Battersea Polytechnic on Thursday evenings from January 19 to March 15. The fee for the series of five lectures is 10s.

A practical course in the inorganic and analytical applications of ion exchange, for which numbers will be strictly limited, is also available.

GERMANY

Potash figures

The West Germany potash industry sold 1,250,700 tons of potash (in terms of K_2O) in the first nine months of this year, against 1,255,400 tons in the corresponding period last year, according to the Burbach Kaliwerke A.G.

Exports accounted for 41.26% of the total sales in the period under review, compared with 38.87% in the same period last year. Domestic sales in the period under review were 4.4% lower than in the same period last year.

Potash production in the first nine months of this year was 1,254,500 tons, against 1,187,900 tons in the corresponding period last year.

JAPAN

Germanium deposit

It is reported that germanium with the highest purity content ever known was discovered recently in Japan. An

analysis has shown that the ore contains 0.1% germanium, five times more than that to be found in the Soviet Union.

NORWAY

Novel waste-pulp technique

One of Norway's largest paper and pulp manufacturers, A/S Borregaard, is to apply a new process converting waste-pulp liquors into power on a large scale. Sterling Drug Inc., New York, whose engineers discovered and developed this technique—the Zimmermann process—has announced that Borregaard would build a $3-million factory at Sarpsborg, near Oslo, for exploiting the new process. The Norwegian company would convert its waste-pulp liquors into steam for use in operating the mills, the announcement added.

A statement issued in London says that Borregaard has entered into a contract with Sterling with regard to the utilisation of Sterling's patents and methods under the Zimmermann process. Borregaard has also secured for itself the sole right for Europe to sell this method to the pulp and paper industry.

According to this statement, the process is based on the not unknown phenomenon that under high pressure one can 'wet oxidise' combustible substances, but Sterling was the first who in the U.S. built a plant on a technical scale, which plant has been in operation about two years with entirely satisfactory results. Sterling has made a number of patent applications and has also been granted several patents concerning the wet oxidation principle as such, as well as for processes which again are based on the wet oxidation principle.

NEW ZEALAND

Paper mill

The first commercial newsprint was made recently at Tasman Pulp & Paper Co.'s giant new paper mill at Kawerau, in the middle of North Island.

In a full year the mill will produce 75,000 tons of newsprint, 36,000 tons of wood pulp and 72 million board ft. of timber.

POLAND

Sulphur deposit

Big resources of sulphur have recently been discovered near Tarnobrzeg, south Poland, according to Warsaw Radio, and construction of sulphur works has already been started. Mining of the sulphur is extremely difficult, as 15 million sq. m. of earth has to be removed first.

SPAIN

Cellulose and paper projects

The National Institute of Industry (I.N.I.) has been empowered to set up a plant in Huelva district with a production capacity of 20,000 tons of fine-quality cellulose or 24,000 tons of paper pulp. The plant will employ some 3,000 workers and it is hoped to start operating in 1958.

Application has been made to erect a new paper factory at Pamplona with a capital of 70 million pesetas. Production of 12,000 tons p.a. is envisaged; it is proposed to import machinery to a value of 10 million pesetas.

PERU

Explosives factory

A company styled Explosivos S.A. has been formed with a capital of U.S. $1.6 million to manufacture industrial explosives in Peru. The main shareholders are Poudreries Réunies de Belgique S.A., Dynamiten Aktien-Gesellschaft and the Cerro de Pasco Corporation. It is planned to erect a factory which will be capable of supplying all national requirements, which at the present time amount to some 5,200 tons p.a. It is understood that the explosives factory will obtain its supplies of nitric acid from Fertilizantes Sinteticos S.A.

BRAZIL

Pyroclore deposits discovered

The discovery is announced of vast deposits of pyroclore, one of the columbite group of minerals, at Araxa, in the State of Minas Gerais. Samples of these deposits, which may possibly amount to as much as 80 million tons, are still being analysed. The deposits occur on property belonging to the company known as Fertilizante Minas Gerais S.A., which was set up at Belo Horizonte in 1953 with capital largely subscribed by the State Government of Minas Gerais, to produce phosphates from valuable apatite deposits at Araxa.

UNITED STATES

Chemicals-from-coal project

Union Carbide & Carbon Co. hopes to be able to start construction of its long-planned plant, for producing chemicals from coal by a hydrogenation process, within the next year or two. The experimental plant, originally costing over $11 million, has had to be revamped and modified and Carbide has spent about $32 million on the entire programme. The company believes that a plant capable of handling 1,000 tons/day of coal is the minimum size for economy. It is estimated that a plant to hydrogenate 1,000 tons/day of coal, including hydrogen production, would probably cost anywhere between $50 million to $100 million.

The process, which has been running experimentally, produces a large variety of chemicals from coal, many of them substances which have never been made commercially before. The experimental plant and process were described in CHEMICAL & PROCESS ENGINEERING, 1953, **34** (6), 165-168.

Salt project

The Pennsylvania Salt Manufacturing Co. and the Hooker Electrochemical Co. have jointly formed a new company to obtain salt for their operations in the Pacific north-west. The new company, the Chemical Salt Production Co., will operate on a 12,000-acre site bordering on Salt Lake, about 40 miles west of Salt Lake City. Completion of its facilities is scheduled by April 1, 1956, and it will have an initial capacity of 120,000 tons p.a. of salt.

The new concern was formed, the parent companies explain, because the expansion rate of the two companies in the north-west would soon exceed the availability of sufficient salt—their basic raw material—from the Pacific coast.

Aluminium plant

Kaiser Aluminium & Chemical Corporation has decided to accelerate and amplify capital expenditure. The firm is undertaking a $90-million expansion programme involving five of its manufacturing plants. Most of the money—$75 million—will be expended on enlarging and completing aluminium sheet and foil facilities now under construction in West Virginia. The project there will be completed by early 1957, a year ahead of the original time-table.

The works will have a capacity of 160,000 tons of sheet and over 60,000 tons of foil p.a. It will be the biggest aluminium fabricating plant to be built in the U.S. in the post-war period.

CANADA

New sulphur plant

Canadian Gulf Oil Corporation plans to construct a 225-tons/day sulphur plant at its Pincher Creek field, some 50 miles south-west of Lethbridge, in Alberta.

The company's initial plant will be the largest in Canada and is being constructed at this time to supply the demands of expanding industry. Work will begin immediately and, when the plant is completed next September,

the company will become a prime producer of sulphur.

Sodium chlorate project

The Electric Reduction Co. of Canada Ltd., an associated company of Albright & Wilson Ltd., have announced plans for a $5-million sodium chlorate plant to be located in north Vancouver. It was announced early in November that construction would start immediately, with the completion date set for late 1956 or early 1957.

Electric Reduction is no newcomer to the chemical industry, although the Vancouver plant will be its first on the west coast. In 1898 the company was founded to produce phosphorus at Buckingham, Quebec, and this site has been expanded over the years to enable the production of chlorates, phosphoric acid, phosphorus sesquisulphide and many other phorphorus-containing compounds to be undertaken. Recently the company completed a $5-million plant for the production of phosphorus at Varennes, Quebec.

For many years the main uses of sodium chlorate have been in weed control and metal treatment, but during the last decade it has become increasingly important as a source of chlorine dioxide for bleaching wood pulp.

MEETINGS

Institution of Chemical Engineers

December 10. 'The Performance Characteristics of 6-in.-diameter Stedman Packing under Reduced Pressures,' by D. G. Cerigo, P. J. King and Prof. F. Morton, 3 p.m., the Midlands Institute, Birmingham.

December 17. 'Some Aspects of Heat Transfer in a Climbing-film Evaporator,' by Prof. J. M. Coulson, 3 p.m., College of Technology, Manchester.

Institute of Physics

December 16. 'The Non-destructive Testing of Non-metals,' by Dr. H. Kolsky, 6.30 p.m., 47 Belgrave Square, London, S.W.1.

Incorporated Plant Engineers

December 12. 'Tar Distillation Plant,' by R. M. Crighton, 7.30 p.m., Mathers Hotel, Dundee.

December 13. 'Corrosion Technology,' by the Mond Nickel Co. Ltd., 7.15 p.m., Engineers' Club, Albert Square, Manchester.

Manchester Association of Engineers

January 6. 'Polythene and its Uses,' by A. Renfrew, 6.45 p.m., Engineers' Club, Albert Square, Manchester.

Recent Publications

Chemical stoneware. From Doulton & Co. Ltd. comes a copy of their latest general catalogue of acid-proof chemical and industrial stoneware. This illustrates a representative range of standard products including rectangular tanks, circular mixing and storage vessels, outlets and cocks, pipelines and fittings, vacuum filters, storage vessels, grinding equipment, tiles, towers and accessories, containers, etc.

Blowers. We have received a copy of publication No. 53 from W. C. Holmes & Co. Ltd. which gives details of Holmes-Connersville AFS, and the more recently designed AFS/A, blowers. Internally, both types of machine are identical, the essential differences being the external appearance. The AFS/A blower has been modernised and given a cleaner, more streamlined appearance. All ribs have been removed, thus facilitating easy cleaning.

Vapour fractometer. A brochure describing the operation of the Model 154 vapour fractometer for analysis of multi-component mixtures of gases or volatile liquids has been published by the Perkin-Elmer Corp. (U.S.). The apparatus, which is based on the principle of gas chromatography, is stated to have wide applications in the petroleum and chemical fields. The 9-page brochure describes the operation, components and uses for the new instrument, as well as giving complete specifications.

Vinyl materials. Concise technical information on the complete range of Geon vinyl resins, latices and compounds is now available from British Geon Ltd. This information is presented in two attractively-set-out summary sheets (SS 1 and 2) specially designed to provide, at a glance, detailed information on the Geon range of vinyl materials. In addition the summary sheets provide an indication of the main uses of each material.

Chemical Engineering Books

The latest book* to come to hand in Newnes' 'Chemical and Chemical Engineering Series' has been produced by a group of specialists in an attempt to fulfil the need for a comprehensive work dealing with the processing techniques, analytical tests and laboratory methods relating to all the important branches of the food industry. The book is divided into two parts, dealing with (1) processing methods and (2) laboratory control, and includes 20 chapters by different authors. The second part of the book contains details of routine laboratory tests. Precise information is also given on the more accurate tests for legal purposes by public analysts and consultants, and tests used for research purposes. Illustrations are included showing the sequence of some of the more important methods.

This book should be useful to chemists and chemical engineers engaged in food processing, and to students who are preparing for careers in the food industries.

Another volume† in this series deals with a wide range of processes and equipment used in chemical engineering practice, ranging from emulsifying processes to the grinding of ores and other substances by ball mills. There is also a section dealing with supersonic and high-frequency vibrators, processes that are likely to assume considerable importance in the not-too-distant future. The authors of the various sections have compiled ample biographies which should be very useful to chemical engineering students.

Practical guidance for chemical engineers and industrial chemists on instruments and controls is the object of a third book,‡ which includes chapters on *p*H meters, photo-electric instruments, polarimeters and increasingly important developments such as the use of ultrasonic equipment in industry and the manipulator box, which has certain applications in the handling of radioactive materials.

Fluid handling is the subject of yet another work in this series, and this volume§ is divided into two main sections dealing with processes and equipment. In the first section there are articles on industrial water treatment; the metering of liquids, steam and gases; the drying of gases; chemical pumping; and centrifugal separators. The second section includes articles on various aspects of centrifuging, filtration and atomising, while pipes, valves, jointing compounds and their applications are discussed in the final sections of the book.

*'Food Technology, Processing and Laboratory Control' (F. Aylward, advisory ed.), 1955. Pp. 307 inc. index, illustrated, 21s.

†'Chemical Engineering Processes and Equipment' (E. Molloy, general ed.), 1955. Pp. 240 inc. index, illustrated, 21s.

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